NEW ENGLAND WATER WORKS ASSOCIATION.

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This Association, as a body, is not responsible for the statements or opinions of any of its members.

WATER-WORKS STATISTICS FOR THE YEAR 1904, IN FORM ADOPTED BY THE NEW ENGLAND WATER WORKS ASSOCIATION.

COMPILED BY CHARLES W. SHERMAN, EDITOR, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

The following tables contain more or less complete statistics for forty-seven water works, which have used, more or less closely, the form adopted by the Association for summarizing statistics. Some of these works report under very few of the headings of the summary.

The editor has made no attempt to compile statistics from water-works reports which do not include at least a partial summary. Some other places have, no doubt, published summaries, but their reports have not been available.

The report of the Committee on Uniform Statistics, containing the form as endorsed for use in the 1901 reports, is printed on page 51 of Vol. XV of the JOURNAL (March, 1902). The page for Financial Statistics was changed by vote of the Association in September, 1902, as reported in the December, 1902, JOURNAL (Vol. XVI, p. 263). Blank forms for use in preparing summaries are printed by the Association, and will be furnished on request.

Previous compilations of statistics may be found in the JOURNAL, as follows:

Statistics for	*Reference to Journal.*
1886	Vol. I, No. 4, p. 29
1887	Vol. II, No. 4, p. 28
1888 to 1892 inclusive	Vol. VII, p. 225

Statistics for	*Reference to Journal.*
1893	Vol. IX, p. 127
1894	Vol. X, p. 131
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1897–99	Vol. XV, p. 65
1900	Vol. XV, p. 367
1901	Vol. XVI, p. 223
1902	Vol. XVII, p. 235
1903	Vol. XVIII, p. 277

In the various tabulations, statistics are given for the following places and years:

Place.	*Year.*
Albany, N. Y.	1900
Andover, Mass.	1900
Arlington, Mass.	1900, 1904
Atlantic City, N. J.	1898, 1900–04
Attleboro, Mass.	1894–1904
Bay City, Mich.	1886–87, 1893–96, 1900–04
Belmont, Mass.	1902–04
Beverly, Mass.	1903
Billerica, Mass.	1899–1904
Boston, Mass.	1886–94, 1897, 1900, 1903
Bridgeport, Conn.	1904
Brockton, Mass.	1893–1904
Burlington, Vt.	1886–1904
Cambridge, Mass.	1900–04
Chelsea, Mass.	1900–04
Cleveland, Ohio	1902–04
Concord, N. H.	1895, 1898, 1900–04
Dover, N. H.	1900
Erie, Pa.	1900
Essex Junction, Vt.	1900
Fall River, Mass.	1886–95, 1897–1904
Fitchburg, Mass.	1886–92, 1894–1904
Freeport, Me.	1901
Geneva, N. Y.	1900
Haverhill, Mass.	1900, 1904
Holyoke, Mass.	1886–92, 1897–98, 1900–04
Hull, England	1900
Ipswich, Mass.	1900
Keene, N. H.	1899–1900, 1903–04
Lawrence, Mass.	1902–04
Leicester, Mass.	1900
Leominster, Mass.	1900
Lewiston, Me.	1900

Place.	*Year.*
Lowell, Mass.	1886, 1897–1904
Lynn, Mass.	1888–98, 1900–04
Madison, Wis.	1900, 1902–04
Manchester, N. H.	1900
Marlborough, Mass.	1900, 1903–04
Maynard, Mass.	1901–03
Metropolitan Water Works, Mass.	1900–04
Middleboro, Mass.	1895–1904
Middletown, Conn.	1902
Minneapolis, Minn.	1900–04
Nantucket, Mass.	1900
Nashua, N. H.	1900, 1904
New Bedford, Mass.	1886–1904
New London, Conn.	1886–1904
Newton, Mass.	1888–1904
Norwich, Conn.	1901
Oberlin, Ohio	1893–1904
Plymouth, Mass.	1886–1904
Providence, R. I.	1897–1904
Quincy, Mass.	1893, 1900–01
Reading, Mass.	1893, 1895–1904
Reading, Pa.	1901–04
Rochester, N. Y.	1903
St. John, N. B.	1902–03
Salem, Mass.	1900
Sandusky, Ohio	1886
Schenectady, N. Y.	1886, 1900–01
Somerville, Mass.	1900–04
Springfield, Mass.	1886–1904
Taunton, Mass.	1886–1904
Toronto, Canada	1893
Trenton, N. J.	1886–87
Troy, N. Y.	1886, 1888–93, 1897–99
Waltham, Mass.	1886–1904
Ware, Mass.	1886, 1888–92, 1900–04
Watertown, Mass.	1900
Wellesley, Mass.	1888–93, 1898–1904
Westerly, R. I.	1902–04
Whitman, Mass.	1897–1904
Wilmington, Del.	1900
Winchendon, Mass.	1900–04
Woburn, Mass.	1900–04
Woonsocket, R. I.	1886–1900, 1902–04
Worcester, Mass.	1900
Yonkers, N. Y.	1893–96, 1900–04

1904.—TABLE 1.—GENERAL AND PUMPING STATISTICS.

Number.	Name of city or town.	Date of construction of works.	By whom owned.	Source of supply.	Mode of supply.	1	2.—Description of fuel used.				
						Builders of pumping machinery.	*a* Kind.	*b* Brand of coal.	*c* Av. price per gross ton.	*d* Per cent. of ash.	*e* Wood. Price per cord.
1	Arlington, Mass.	1872 1894	Town.	Metropolitan W.W.	.....	.....	.....	.....	.....	..	...
2	Atlantic City, N. J.	1882 1888	City.	Wells and Absecon Creek.	Pumping.	Worthington, Gordon-Max'll, d'Auria, Rand, Smith-Vaile.	Bituminous.	Standard, Eureka, Priscilla.	$4 00	10	...
3	Attleboro, Mass.	1873	Town.	Well.	Pumping.	Deane, Barr.	Bituminous.	New River.	.....	...	...
4	Bay City, Mich.	1872	City.	Saginaw Bay.	Pumping.	Holly.	Bituminous.	Slack.	1 98	23	$2 50
5	Belmont, Mass.	1887	Town.	Metropolitan W.W.	.....	.....	.....	.....	.....	..	...
6	Billerica, Mass.	1898	Town.	Driven Wells.	Pumping.	Barr.	Bituminous.	New River, Victor.	4 86	..	...
7	Bridgeport, Conn.	1858	Co.	Streams.	Gravity and Pumping.	Worthington.	Bituminous.	.....	4 00	..	...
8	Brockton, Mass.	1880	City.	Storage Reserv'r on Salisbury Brook; Silver Lake.	Pumping.	.....	.....	.....	.....	..	...
9	Burlington, Vt.	1867–8	City.	Lake Champlain.	Pumping.	Worthington.	Bituminous.	Nonpareil, Clearfield.	4 10 3 465	..	...
10	Cambridge, Mass.	1855	City.	Hobbs Brook, Stony Brook, Fresh Pond.	Pumping.	Leavitt (Gro'n) Worthington, Blake.	Bituminous.	Cumberland, New River.	4 20	..	...
11	Chelsea, Mass.	1867	City.	Metropolitan W.W.	.....	.....	.....	.....	.....	..	...
12	Cleveland, Ohio.	1856	City.	Lake Erie.	Pumping.	Worthington, Knowles, Allis, Kilby, Holly.	Bituminous.	Salineville Slack, Pittsb'g Sl'ck.	1 79	..	...
13	Concord, N. H.	1872	City.	Penacook Lake.	Gravity and Pumping.	.....	.....	.....	.....	..	...

14	Fall River, Mass.	1874	City.	N. Watuppa Lake.	Pumping.	Worthington, Davidson.	Bituminous.	Cumberland, Georges Cr.	.....	..	...
15	Fitchburg, Mass.	1873	City.	Storage Reservoir.	Gravity.	.....	.....	.....	.....	..	...
16	Haverhill, Mass.	..	City.	Ponds.	Gravity and Pumping.	Worthington, Deane, Barr.	Bituminous.	Cumberland, Carbon.	$5 20	9.5	...
17	Holyoke, Mass.	1873	City.	Lakes, Streams, and Manhan River.	Gravity.	.....	.....	.....	.....	..	...
18	Keene, N. H.	1868	City.	Sylv'n & Echo L'k's.	Gravity.	.....	.....	.....	.....	..	...
19	Lawrence, Mass.	1874–5	City.	Merrimac River.	Pumping.	Barr, Morris.	Bituminous.	Georges Cr., New River.	5 53	8.18	...
20	Lowell, Mass.	1870–3	City.	Driven Wells.	Pumping.	Morris, Worthington, Deane, Knowles.	Bituminous.	Sonman, New River.	4 75	..	...
21	Lynn, Mass.	1871	City.	Ponds and River.	Pumping.	Leavitt, Loretz.	Bituminous.	Georges Cr.	4 75	11	..
22	Madison, Wis.	1882–3	City.	Artesian Wells.	Pumping.	Allis, Knowles.	Anthracite.	Pea.	6 98	..	...
23	Marlboro, Mass.	1883	City.	Lake Williams, Millham Reserv'r.	Pumping.	Blake, Worthington, Barr.	Bituminous.	Various.	5 09	..	...
24	Metropolitan Water Works, Mass.	1848 1872 1895	State of Massachusetts.	L. Cochituate, Sudbury River, Nashua River.	Pumping, 74%. Gravity, 26%.	*Chestnut Hill* Holly, Quint'd, Allis.	*Hill High* Bituminous. Anthracite.	*Service Stat'n.* Quemahoning George's Cr., Pocahontas, Cumberl'nd. Buckwheat, Screenings.	3 87	12	...
						Chestnut Hill Holly.	*Low Service* Bituminous. Anthracite.	*Station.* Quemahoning Georges Cr., Pocohantas, Cumberl'nd. Buckwheat, Screenings.	3 97	12	...
						Spot Blake, Holly.	*Pond* Bituminous. Anthracite.	*Station.* Georges Cr., Cumberland. Buckwheat, Screenings.	3 65	14	...

1904.—TABLE 1, *Continued.*—GENERAL AND PUMPING STATISTICS.

Number.	Name of city or town.	Date of construction of works.	By whom owned.	Source of supply.	Mode of supply.	1	2.—Description of fuel used.				
						Builders of pumping machinery.	*a* Kind.	*b* Brand of coal.	*c* Av. price per gross ton.	*d* Per cent. of ash.	*e* Wood. Price per cord.
25	Middleboro, Mass.	1885	Fire Dist.	Well.	Pumping.	Deane.	Bituminous.	Pocahontas, Georges Cr., Pardee.	$4 55–5 80	..	...
26	Minneapolis, Minn.	1868	City.	Mississippi River.	Pumping.	Strothman,[1] Worthington, Holly.	Sawdust, edgings, etc. (Sta. No. 3), Coal (Sta. No. 4).	.....	.....	..	...
27	Nashua, N. H.	1853	Co.	Pennichuck Br. and Springs.	Pumping.	Snow, Deane.	.....	.....	.....	..	...
28	New Bedford, Mass.	1866	City.	Quittacas Ponds.	Pumping.	McAlpine, Worthington, Dickson.	Bituminous.	Georges Cr. Cumberland.	5 67	7	...
29	New London, Conn.	1872	City.	Lake Konomoc & Barns Reservoir.	Gravity and Pumping.	.....	.....	.....	.....	..	...
30	Newton, Mass.	1876	City.	Coll. Gallery near Charles River.	Pumping.	Worthington.	Bituminous. Anthracite.	Pocahontas, New River, Screenings.	3 77	10	$6 00
31	Oberlin, Ohio.	1887	Village.	East Branch of Vermilion River.	Pumping.	Deane.	Bituminous.	Pocahontas.	4 00	..	...
32	Plymouth, Mass.	1855	Town.	Gt & Little South and Lout Ponds.	Gravity and Pumping.	Barr, Worthington.	Bituminous.	Various.	4 90–5 50	..	...
33	Providence, R. I.	1870	City.	Pawtuxet River.	Pumping.	Worthington, Paulding-Kemble, Corliss, Providence, Holly.	Bituminous. Bituminous. Anthracite. Bituminous.	Georges Cr., Pocahontas, New River. Georges Cr., New River. Buckwheat. New River.	4 72 4 57 2 75 4 26	11 14 21 9	4 50 4 50 4 09 4 50

						liss, Providence, Holly.	Anthracite.	New River.				
							Bituminous.	Buckwheat.	2 75	21	4 09	
								New River.	4 26	9	4 50	
34	Reading, Mass.	1890	Town.	Filter Gallery.	Pumping.	Blake.	Bituminous.	Pocahontas.	$5 35	..	...	
35	Reading, Pa.	1819	City.	Creeks and Springs.	Gravity and Pumping.	Worthington, Allis-Chalmers.	Bituminous, Anthracite.	.....	2 96	9	$3 50	
36	Somerville, Mass.	1868	City.	Metropolitan W.W.	.....	.....	.....	.....	.....	..	...	
37	Springfield, Mass.	1864	City.	Reservoirs.	Gravity.	.....	.....	.....	.....	..	...	
38	Taunton, Mass.	1876	City.	Lakeville Ponds.	Pumping.	Holly, Allis.	Bituminous.	Georges Cr., Cumberland.	5 25, 4 75 & 5 50	..	...	
39	Waltham, Mass.	1872	City.	Filter Basin.	Pumping.	Barr, Worthington.	Bituminous, Anthracite.	Pocahontas. Screenings.	4 35	12	...	
40	Ware, Mass.	1886	Town.	Wells.	Pumping.	Deane, Warren.	Bituminous.	.....	5 00	..	4 50	
41	Wellesley, Mass.	1884	Town.	Wells.	Pumping.	Blake.	Bituminous.	Puritan, Georges Cr.	4 71	11	3 50	
42	Westerly, R. I.	1886	Town.	Driven Wells.	Pumping.	Worthington.	Bituminous.	Georges Cr.	4 78	..	6 00	
43	Whitman, Mass.	1883	Town.	Silver Lake [Brockton W. W.]	Pumping.	Blake, Worthington.	.....	.....	.....	..	...	
44	Winchendon, Mass.	1896	Town.	Well.	Pumping.	Blake.	Bituminous.	.....	5 50	11	...	
45	Woburn, Mass.	1872	City.	Filter Gallery.	Pumping.	Blake, Worthington.	Bituminous.	Carbon, New River.	5 63	9	...	
46	Woonsocket, R. I.	1884	City.	Crook Falls Brook.	Pumping.	Worthington, Deane.	Bituminous.	Georges Cr., Pocahontas.	4 78	7	3 00	
47	Yonkers, N. Y.	1874	City.	Streams and Wells.	Pumping.	Wright, Worthington, Wood.	Bituminous.	Georges Cr.	4 14	11	12 00	

[1] Stations 1 and 2, water power.

1904. — TABLE 1, *Concluded.* — PUMPING STATISTICS.

Number.	3 Coal consumed for the year. (Lbs.)	4 Lbs. of wood ÷ 3 = equivalent coal.	4a Amount of other fuel used.	5 Total equivalent coal consumed for the year. (Lbs.)(3) + (4).	6 Total pumpage for the year in gallons.	7 Average static head against which pumps work. (Feet.)	8 Average dynamic head against which pumps work. (Feet.)	9 Number of gallons pumped per lb. of equivalent coal.	10 Duty in foot-pounds per 100 pounds of coal. No deductions.	11 Cost per million gallons pumped into reservoir, figured on pumping station expenses.	12 Cost per million gallons raised 1 foot high, figured on pumping station expenses.
2	5 458 459	3 000	.....	5 461 459	1 626 721 780	95	126	298	30 916 015 [1]	$10 96	$0 087
	868 811	500	.....	869 311	158 824 569	120	135	183	20 570 193	26 95	0 200
3	775 191	..	.....	.....	202 919 700	...	188 225	268	50 300 000	.....	.....
4	4 909 400	3 600	.....	4 913 000	1 091 013 063 [2]	...	113	222	20 928 000	8 04	0 071
6	326 141	..	.....	.....	36 718 020 [2]	286	316	113	29 708 860	53 99	0 171
7	1 261 120	..	.....	1 261 120	826 800 360 [2]	100	115	655	62 697 000	.....	.....
9	.....	..	.....	.....	360 312 725	289	316	....	.....	19 04	0 07
10	3 650 513	500	.....	.....	2 831 342 145 [2]	158	194	786	130 762 300	6 11	0 031
12	66 849 700	..	.....	66 849 700	22 535 360 018 [2]	173 326	219	337	61 481 744	5 55	0 025
13	401 146	10 911	.....	.....	201 443 995	...	...	499	.....	.....	.....
14	.....	..	.....	.....	1 497 523 220	...	186	339	.....	11 99	.....
16	1 909 598	500	.....	1 910 098	1 015 701 696 [3]	182	201	700 240	89 261 449	10 22	0 051
19	243 761	..	.....	.....	78 001 236 [3]	290	318	325	85 771 219	14 34	0 096
	2 115 714	..	.....	.....	949 449 414	152	185	494	69 777 817		0 071
20	8 386 937	2 400	.....	8 389 337	2 007 487 767	156 [4]	164 [4]	239 538 [4]	73 640 173 [4]	19 69 L	0 120 L
21	16 500	..	.....	16 500	9 266 200 [3]	154	155	550	82 126 041	8 14	0 006
	3 531 500	320	.....	3 531 820	1 943 952 500	151	153	562	79 193 335	.....	.....
22	1 762 300	..	.....	.....	547 834 400	201	231	....	.....	31 05	0 134
23	735 400	..	.....	.....	221 262 300 [3]	164	173	301	43 410 616	13 33	0 077
*24a	1 012 902	..	.....	.....	576 200 000 [3]	...	121	568	65 400 000 [5]	7 17	0 059
b	279 676	..	.....	.....	292 860 000 [3]	...	128	1 047	120 540 000 [5]	4 53	0 035
c	8 656 737	..	.....	.....	10 522 750 000 [3]	...	129	1 215	134 950 000 [5]	2 81	0 022
d	8 662 868	..	.....	.....	20 268 940 000 [3]	...	55	2 340	110 290 000 [5]	1 67	0 030
e	2 462 802	..	.....	.....	2 927 470 000 [3]	...	129	1 189	132 070 000 [5]	4 05	0 031
25	634 250	..	.....	.....	93 227 000 [2]	182	204	147	25 007 913	28 27	0 14
26	6 958 959	..	13 983 [6] cords sawdust, etc.	15 150 480	6 72 3 171 240	218	238	....	56 061 705 75 515 499 110 047 657 112 707 857	.....	.....

26	6 958 959	..	13 983 [6] cords sawdust, etc.	15 150 480	6 72 3 171 240	218	238	....	56 061 705 75 515 499 110 047 657 112 707 857	.....	.....
28	3 082 575	..	.....	3 082 575	2 562 598 170 [3]	167	185	831	128 277 825	$7 49	$0 045
30	3 649 240	6 000	.....	3 655 240	799 765 400 [3]	235	257	219	46 897 100	13 52	0 05
31	486 315	..	.....	486 315	73 000 000 [3]	80	84	150	10 520 000	29 22	0 35
32	326 890	..	.....	.....	121 212 352	65	73	371	23 386 577	15 13	0 207
	194 400				81 157 764			418			
	7 015 400	667	.....	7 016 067	3 576 092 908 [3]	171	177	510	75 283 478		
33	1 792 800	5 000	.....	1 797 800	1 206 472 894	171	178	671	99 590 022	7 04	0 040
	1 189 590	2 484	.....	1 192 074	556 620 531	115	130	467	50 442 014	16 38 [7]	0 112 [7]
	1 117 500	417	.....	1 117 917	361 793 205	167	177	324	47 768 443		
34	466 820	..	.....	.....	56 279 377	219	240	120	24 131 106	64 60	0 269
35	5 874 700	1 800	.....	5 876 500	1 473 045 733 [3]	213	266	251	55 567 200	8 88	0 033
38	1 206 000	..	.....	.....	642 538 734	...	...	....	.....	.....	.....
	406 400				547 832 019	...	69	....	30 616 902	12 05	0 174
39	1 327 685	..	.....	.....	758 640 923 [3]	164	180	608 270	97 241 220	10 63	0 059
40	655 509	1 500	.....	657 009	128 199 820 [3]	221	244	195	39 705 922	24 66	0 10
41	663 814	317	.....	664 131	114 689 955	260	280	172	40 325 433	26 22	0 94
42	1 400 928	782	.....	1 401 710	250 957 400 [3]	195	210	179	31 356 000	22 70	0 108
43	491 291	..	.....	.....	59 666 710	...	...	....	.....	.....	.....
44	273 114	..	.....	273 114	32 222 281 [3]	246	289	143	33 941 887	36 40	0 12
45	1 962 500	..	.....	.....	520 284 450 [3]	196	214	265	47 360 545	15 86	0 074
46	1 682 050	354	.....	1 682 404	400 274 615 [3]	239	240	238	47 624 693	13 79	0 057
47	6 100 856	..	.....	.....	2 023 809 108 [3]	185	218	268	60 311 697	12 45	.....

[1] Part of supply pumped twice.
[2] Without allowance for slip.
[3] With allowance for slip.
[4] West Sixth Street Station.
[5] Figured on plunger displacement.
[6] 1 cord sawdust equivalent to 585,8 lbs. coal.
[7] H. S., pumped twice.
*24*a*. C. H. H. S. Station, engines 1 and 2.*
b. C. H. H. S. Station, engine 3.
c. C. H. H. S. Station, engine 4.
d. C. H. L. S. Station, engines 5, 6, and 7.
e. Spot Pond Station, engine 9.

1904.—TABLE 2.—FINANCIAL STATISTICS.

Number.	Name of city or town.	Receipts.						
		Balance brought forward.		Water rates.			Municipal departments.	
		a	b	A	B	C	D	E
		From ordinary receipts.	From extraordinary rec'pts.	Fixture rates.	Meter rates.	Total from consumers.	For hydrants.	For fountains.
1	Arlington, Mass.	$10 375 77	.....	$34 346 00	$4 686 60	$39 032 62	.....	.....
2	Atlantic City, N. J.	85 380 97	$67 139 39	.....	.....	124 604 19	.....	.....
3	Attleboro, Mass.	.....	6 036 93	.....	.....	31 248 03	.....	.....
4	Bay City, Mich.	10 803 01	.....	9 378 75	16 625 64	26 004 39	.....	.....
5	Belmont, Mass.	1 382 81	104 14	.....	14 006 23	14 006 23	.....	.....
6	Billerica, Mass.	.....	.....	1 100 19	2 492 47	3 592 66	$2 300 00	.....
8	Brockton, Mass.	.....	52 405 28	3 022 03	89 637 56	92 659 59	3 000 00	.....
9	Burlington, Vt.	.....	.....	7 262 77	37 836 83	45 099 60	3 560 00	.....
10	Cambridge, Mass.	.....	.....	.....	.....	342 483 02	.....	.....
11	Chelsea, Mass.	.....	.....	83 778 32	30 182 07	113 960 39	.....	.....
12	Cleveland, Ohio	354 368 62	.....	268 932 26	507 525 36	776 457 62	.....	.....
13	Concord, N. H.	.....	.....	29 248 28	38 522 23	.....	.....	.....
14	Fall River, Mass.	138 261 85	.....	2 775 38	178 381 38	.....	.....	.....
15	Fitchburg, Mass.	.....	.....	19 714 40	47 000 87	.....	.....	.....
16	Haverhill, Mass.	552 69	.....	81 168 21	19 852 47	101 020 68	.....	.....
17	Holyoke, Mass.	11 601 46	.....	81 902 71	25 769 84	107 672 55	.....	.....
18	Keene, N. H.	.....	.....	.....	.....	25 507 77	5 850 00	$350 00
19	Lawrence, Mass.	.....	.....	.....	.....	115 974 61	.....	.....

18	Keene, N. H.	.....	.....	.....	.....	25 507 77	5 850 00	$350 00
19	Lawrence, Mass.	.....	.....	.....	.....	115 974 61	.....	.....
20	Lowell, Mass.	$3 059 92	.....	$36 153 69	$138 121 52	$174 275 21	.....	.....
21	Lynn, Mass.	.....	.....	110 890 67	103 824 10	214 714 77	.....	.....
22	Madison, Wis.	1 358 17	.....	.....	.....	26 465 77	.....	.....
23	Marlboro, Mass.	1 502 76	.....	11 347 30	25 400 12	36 747 42	$6 760 00	.....
25	Middleboro, Mass.	2 830 89	$151 42	3 555 94	7 408 27	10 964 21	.....	.....
28	New Bedford, Mass.	4 696 37	13 770 36	77 121 73	52 313 16	129 434 89	.....	.....
29	New London, Conn.	83 021 22		.....	.....	61 428 20	.....	.....
30	Newton, Mass.	.....	.....	2 640 00	112 725 00	115 365 00	.....	.....
31	Oberlin, Ohio	.....	.....	653 35	8 744 25	9 397 60	.....	.....
32	Plymouth, Mass.	.....	2 456 52	.....	.....	27 867 32	.....	.....
34	Reading, Mass.	75 93	337 95	.....	10 161 40	10 161 40	4 890 00	$300 00
35	Reading, Pa.	24 654 83	.....	144 165 55	49 003 36	193 168 91	.....	.....
36	Somerville, Mass.	.....	.....	155 476 73	60 550 61	216 027 34	.....	.....
37	Springfield, Mass.	11 816 19	.....	152 148 99	92 618 78	244 767 77	20 320 00[1]	1 927 00[1]
38	Taunton, Mass.	.....	2 628 01	.....	.....	65 349 45	.....	.....
39	Waltham, Mass.	4 061 10	6 141 80	56 871 67	15 724 58	72 596 25	.....	.....
40	Ware, Mass.	2 830 30	148 39	.....	9 124 33	.....	1 000 00	171 45
41	Wellesley, Mass.	4 891 36	.....	.....	18 095 26	18 095 26	(———	3 500 00
42	Westerly, R. I.	6 227 42	.....	2 756 10	26 199 42	28 955 52	3 433 34	.....
43	Whitman, Mass.	.....	1 371 32	2 212 25	6 152 38	8 364 63	2 780 00	.....
44	Winchendon, Mass.	1 026 37	81 01	62 61	5 894 20	5 956 81	4 520 00	305 00
45	Woburn, Mass.	.....	.....	36 112 63	8 937 67	45 050 30	.....	275 00
46	Woonsocket, R. I.	.....	.....	2 527 05	61 547 35	64 074 40	16 945 00	2 704 82
47	Yonkers, N. Y.	4 668 84	34 132 27	.....	.....	151 345 40	21 110 00	.....

[1]Book account only.

1904.—TABLE 2, *Continued.*—FINANCIAL STATISTICS.

Number	RECEIPTS—*Continued.*								
	Municipal departments—*Continued.*								
	F For street watering.	G For public buildings.	H For miscellaneous uses.	I General appropriation.	J Total from departments.	K From tax levy.	L From bond issue.	M From other sources.	N Total receipts.
1	.....	.....	.....	.....	.....	.....	$3 500 00	$2 495 38	$55 503 75
2	$3 118 48	.....	.....	.....	.....	$41 000 00	.....	1 027 78	327 723 63
3	.....	.....	.....	.....	.....	3 000 00	22 142 89	5 452 82 276 27	.....
4	.....	.....	.....	.....	.....	18 430 00	19 000 00	356 75	75 376 19
5	.....	.....	.....	.....	.....	.....	5 500 00	782 04 565 48	21 598 66
6	.....	$100 36	.....	.....	$2 400 36	2 369 45	.....	29 40	8 391 87
8	1 000 00	.....	.....	.....	4 000 00	.....	190 000 00	2 874 58	.....
10	.....	.....	.....	.....	.....	.....	.....	14 756 85	353 828 07
11	.....	.....	.....	.....	.....	.....	.....	1 705 16	115 665 55
12	.....	.....	.....	.....	.....	.....	399 095 33	64 569 97	1 594 491 54
14	.....	.....	.....	.....	.....	.....	20 000 00	9 197 69	.....
15	.....	.....	.....	.....	.....	.....	.....	5 368 95	72 084 22
16	.....	.....	.....	.....	.....	.....	.....	13 795 01	115 368 38
17	.....	.....	.....	.....	.....	.....	.....	6 300 90	125 574 91
18	1 500 00	200 00	.....	.....	7 900 00	.....	.....	.....	33 407 77
19	.....	.....	.....	.....	.....	.....	.....	.....	115 974 61
20	1 200 00	5 500 00	.....	.....	6 700 00	17 800 00	.....	16 098 43	217 933 56
21	.....	.....	.....	.....	.....	.....	99 213 58	10 404 72	324 333 07

21	.....	.....	.....	.....	.....	.....	99 213 58	10 404 72	324 333 07
22	.....	.....	.....	.....	.....	$10 000 00	$20 362 89	₹	$60 081 15
23	.....	$235 90	$22 73	.....	$7 018 63	.....	1 076 00	$2 323 97	48 668 78
25	.....	.....	.....	$1 500 00	1 500 00	.....	.....	204 11	.....
28	.....	.....	.....	12 000 00	12 000 00	67 480 00	.....	357 97	227 381 62
29	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	$3 000 00	2 858 00	.....	.....	5 858 00	.....	37 801 15	9 053 00	.....
31	.....	.....	.....	.....	.....	3 510 00	.....	4 605 06 883 53	13 751 03
32	.....	.....	.....	.....	.....	3 500 00	1 440 00	1 295 52	.....
34	500 00	.....	.....	.....	5 690 00	1 300 00	.....	764 18	18 329 46
35	.....	.....	.....	.....	.....	.....	.....	9 316 68	227 140 42
36	.....	.....	.....	.....	.....	.....	.....	8 081 60	224 108 94
37	6 269 58[1]	13 363 99[1]	.....	.....	41 880 57[1]	.....	.....	684 00[1] 266 541 89 107 57	321 030 22
38	.....	855 54	.....	.....	.....	15 000 00	.....	15 058 80 826 60	.....
39	.....	.....	469 02	.....	469 02	.....	.....	4 526 40	87 794 57
40	.....	484 30	365 29	.....	.....	2 700 00	.....	515 73	.....
41	———)	212 60	115 00	.....	3 827 60	.....	3 000 00	2 044 85	31 859 07
42	.....	.....	.....	.....	3 433 34	.....	2 021 51	3 943 69	44 581 48
43	.....	.....	.....	.....	.....	2 000 00	20 000 00	.....	.....
44	126 90	.....	.....	.....	4 951 90	2 500 00	.....	.....	14 516 09
45	250 00	255 00	.....	.....	780 00	.....	.....	116 14	.....
46	2 642 82	1 189 76	559 18	1 500 00	39 081 58	.....	.....	911 89 32 45	103 188 43
47	.....	.....	.....	.....	.....	.....	159 541 00	2 344 11	.....

[1] Book account only.

1904.—TABLE 2, *Continued.*—FINANCIAL STATISTICS.

Number.	Maintenance Expenditures.			DD	EE	FF	Construction Expenditures.				
	AA	BB	CC				GG	HH	II	JJ	KK
	Operation.	Special.	Total maintenance.	Interest on bonds.	Payment of bonds.	Sinking fund.	Extension of mains.	Extension of services.	Extension of meters.	Special.	Total constr'tion.
1	$6 565 26	$12 972 76[1]	$19 538 02	$12 760 00	.....	$10 000 00	$3 217 34	$817 37	$229 20	.....	$4 263 91
2	56 437 82	.....	.....	57 999 50	.....	31 500 00	15 778 28	2 195 41	2 340 19	$50 553 77	70 867 65
3	.....	.....	17 245 92	13 645 00	.....	5 500 00	.....	.....	.....	.....	21 056 87
4	15 554 33	.....	15 554 33	18 430 00	$19 000 00	.....	10 697 29	.....	783 21	.....	11 480 50
5	1 688 09	6 391 85[1]	.....	1 660 00	2 250 00	520 00	6 269 61	697 59	288 62	.....	7 255 82
6	.....	.....	2 892 00	3 600 00	.....	1 800 00	.....	.....	.....	.....	99 87
8	30 713 52	.....	.....	50 722 50	.....	.....	37 242 02	3 152 88	2 726 33	161 811 04	204 932 27
9	28 906 43	.....	.....	9 920 00	.....	.....	2 387 99	412 01	.....	.....	.....
10	.....	.....	97 845 40	126 126 50	.....	121 522 50	.....	.....	3 999 12	.....	21 851 98
11	12 455 25	44 507 49[1]	56 962 74	12 000 00	.....	5 410 00	.....	.....	.....	.....	3 578 41
12	371 032 03	2 100 00	373 132 03	149 500 00	.....	.....	278 330 24	.....	88 271 21	245 070 69	611 672 14
14	56 363 25	.....	.....	92 747 50	125 000 00	.....	.....	.....	.....	11 637 29 20 000 00	.....
15	37 998 82[2]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	20 806 74	.....	20 808 74	39 640 00	5 000 00	18 000 00	3 822 74	5 504 03	473 41	829 82	10 630 00
17	32 481 27	3 263 57	35 744 84	13 750 00	.....	5 600 00 21 243 06	1 808 82	.....	723 40	37 677 20	40 209 42
18	.....	.....	2 651 02	3 970 00	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	59 352 09	32 080 00	.....	15 429 00	8 598 18	2 366 13	[3]	46 30	11 010 16
20	88 357 69	.....	88 357 69	45 631 00	21 600 00	17 800 00	8 843 67	4 899 13	2 328 79	.....	16 071 59

19	.....	.....	59 352 09	32 080 00	.....	15 429 00	8 598 18	2 366 13	[3]	46 30	11 010 16	
20	88 357 69	.....	88 357 69	45 631 00	21 600 00	17 800 00	8 843 67	4 899 13	2 328 79	.....	16 071 59	
21	$108 327 61	.....	$108 327 61	$85 791 88	.....	$31 000 00	.....	$9 048 62	.....	$83 728 16	$92 776 78	
22	.....	.....	3 220 18 16 911 69	.....	.....	.....	.....	.....	.....	.....	21 989 48	
23	8 998 66	$225 99	9 224 65	20 760 00	.....	.....	.....	.....	.....	.....	3 621 37	
25	5 053 33	.....	5 053 33	1 940 00	.....	5 000 00	$310 07	580 46		.....	890 53	
28	49 021 16	.....	49 021 16	72 480 00	$30 000 00	44 000 00	19 976 23	5 578 37	$2 379 99	2 403 78	30 338 37	
29	9 591 74	498 61	10 090 35	21 915 35	.....	.....	11 196 13	2 728 87	1 093 76	14 925 61	29 944 37	
30	19 981 00	.....	.....	101 315 00	.....	.....	13 210 88	8 526 45	2 980 76	13 105 44	42 406 21	
31	5 142 74	.....	5 142 74	1 778 06	2 000 00	.....	376 14	620 81	813 77	4 582 68 1 972 28	4 070 69	
32	11 899 36	.....	.....	4 730 80	8 306 66	.....	9 972 04	307 85	.....	287 69 6 949 35	17 229 24	
34	6 037 71	735 96	6 773 67	8 425 00	.....	.....	934 00	1 475 96	331 83	362 55	3 104 34	
35	55 485 97	1 515 24	57 001 21	15 700 00	.....	11 500 00	15 811 73	.....	3 761 40	2 220 01 39 934 42 56 624 71	118 352 27	
36	25 665 40	86 736 93[1] 3 324 89	.....	4 850 00	15 000 00	.....	8 490 48	3 880 99	10 448 06	162 95	22 982 48	
37	32 869 74	31 150 55 213 83 18 970 65	.....	36 675 00	.....	112 508 44	6 163 18	.....	.....	25 981 20	32 144 38	
38	29 458 64	.....	.....	33 693 00	.....	3 024 41	23 552 08	1 711 33	1 084 13	5 336 45	31 683 99	
39	30 713 81	.....	30 713 81	17 605 00	.....	25 000 00	.....	.....	.....	.....	9 421 71	
40	9 744 33	.....	.....	.....	.....	.....	.....	.....	.....	.....	4 248 39	
41	7 088 28	67 30	7 150 58	11 280 00	.....	.....	2 831 43	696 75	596 09	.....	4 124 27	
42	9 675 56	.....	9 675 56	12 357 92	.....	2 251 20	5 697 14	2 326 46	1 527 79	.....	9 551 39	
43	.....	.....	4 985 21	4 000 00	.....	2 000 00	.....	.....	.....	.....	23 277 14	
44	4 267 35	.....	4 267 35	3 500 00	2 000 00	.....	1 936 37	377 96	364 46	1 174 58	3 853 37	
45	16 916 60	.....	.....	1 652 00	.....	27 687 28	.....	602 95	.....	.....	602 95	
46	15 371 84	.....	.....	38 280 00	.....	.....	.....	18 101 89	.....	.....	.....	
47	71 354 81	.....	.....	84 113 84	.....	24 000 00	.....	.....	.....	.....	214 361 44	

[1] Metropolitan water-works assessment.

[2] Including extension of mains.

[3] Charged to Maintenance.

1904.—TABLE 2, *Concluded.*—FINANCIAL STATISTICS.

Number.	LL	MM Balance.		N		O	P	Q	R
	Unclassified expenses.	*aa* Ordinary.	*bb* Extraordinary.	Total.	Disposition of balance.	Net cost of works to date.	Bonded debt at date.	Value of sinking fund.	Average rate of interest. Per cent.
1	.....	$8 559 16	$282 66	$55 403 75	Forward.	$498 000 00	$322 000 00	$19 000 00	4
2	.....	94 333 04	16 585 62	327 723 63	Forward.	1 370 191 31	1 244 000 00	214 806 92	4¼
3	.....	.....	5 256 33	.....	.....	472 910 70	337 000 00	35 397 67	.....
4	.....	10 911 36	.....	75 376 19	.....	641 606 36	342 000 00	.....	5.4
5	.....	1 438 77	394 13	.....	.....	.....	39 250 00	4 390 69	4
6	.....	.....	.....	8 391 87	.....	92 320 28	90 000 00	11 572 61	5
8	.....	18 098 15	52 229 86	.....	.....	1 532 501 89	1 415 000 00	509 135 02	3.6
9	.....	8 210 35	.....	.....	.....	483 600 65	248 000 00	53 000 00	4
10	$7 291 63	.....	.....	374 638 01	.....	5 772 507 13	3 350 600 00	1 218 686 74	3½ to 4
11	567 27	37 147 13	.....	115 665 55	City Treasury.	499 112 32	300 000 00	82 607 00	4
12	3 058 26	457 129 11	.....	1 594 491 54	Forward.	9 530 162 00	3 950 000 00	0	4
14	.....	42 868 26	.....	.....	.....	2 032 418 21	1 975 000 00	842 631 45	4.7
15	.....	34 096 40	.....	72 084 22	City Treasury.	421 380 78	567 000 00	145 619 22	.....
16	.....	21 291 24	.....	115 368 38	.....	1 404 167 03	986 000 00	240 951 53	4
17	1 816 77	7 210 82	.....	125 574 91	.....	1 295 308 26	350 000 00	71 587 95	.....
18	.....	26 786 75	.....	33 407 77	City Treasury.	.....	.....	.....	.....
19	.....	.....	.....	117 871 70[1]	.....	2 231 340 42	752 000 00	66 053 27	5
20	9 637 96	18 835 32	.....	217 933 56	Forward.	2 996 402 05	1 075 000 00	406 430 22	4

19	.....	.....	.....	117 871 70[1]	.....	2 231 340 42	752 000 00	66 053 27	5
20	9 637 96	18 835 32	.....	217 933 56	Forward.	2 996 402 05	1 075 000 00	406 430 22	4
21	.....	.....	$6 436 80	$324 333 07	Forward.	$2 900 890 89	$2 160 000 00	$746 585 78	4
22	.....	$17 959 80	.....	60 081 15	.....	414 281 78	37 500 00	.....	3¾ to 4
23	.....	15 062 26	.....	48 668 78	.....	591 343 90	519 000 00	198 072 31	4
25	.....	3 124 74	.....	.....	.....	118 987 88	45 500 00	13 967 34	4
28	.....	1 542 09	.....	227 381 62	Forward.	3 261 678 78	1 638 000 00	292 016 99	4.34
29	$35 000 00	(62 2 19 70)		.....	.....	980 250 93	601 000 00	.....	3.59
30	.....	8 980 00	.....	.....	.....	2 189 775 31	2 185 000 00	1 150 335 00	4.6
31	964 41	—204 87	.....	13 751 03	.....	112 644 96	—49 000 00	.....	3.8
32	.....	.....	.....	.....	.....	355 318 21	117 173 14	.....	3½ to 4
33	.....	.....	.....	.....	.....	6 638 894 92	5 674 000 00	1 400 326 60	3.85
34	.....	(26 45)		18 329 46	Forward.	289 811 96	209 000 00	.....	4
35	1 306 98	23 279 96	.....	227 140 42	Forward.	2 324 191 57	400 000 00	32 690 57	4
36	982 91	64 566 33	.....	244 108 94	City Treasury.	838 706 95	108 000 00	.....	4
37	41 791 90	14 705 73	.....	320 922 65	.....	2 278 678 57	835 000 00	194 192 15	4.31
38	.....	.....	1 002 82	.....	.....	1 324 509 96	842 200 00	288 871 57	3½ to 4
39	.....	3 807 56	1 246 49	87 794 57	.....	632 753 51	455 000 00	221 335 26	3.88
40	.....	3 347 07	191 26	.....	.....	141 765 03	30 600 00	.....	3½ to 4
41	3 852 35[2]	4 768 82	683 05	31 859 07	Forward.	339 530 87	284 000 00	123 787 30	4
42	.....	.....	.....	.....	Forward.	369 482 64	353 000 00	51 194 18	3¾
43	.....	.....	2 608 85	.....	.....	157 689 89	120 000 00	48 473 03	4
44	.....	835 37	.....	14 516 09	.....	129 674 56	87 000 00	.....	4
45	.....	.....	.....	.....	.....	603 668 99	19 700 00	.....	4
46	.....	596 08	.....	72 349 81	.....	224 212 89	982 000 00	129 020 89	3.8
47	.....	.....	—20 688 17	.....	.....	1 994 671 57	1 760 000 00	358 894 69	5.33

[1] Excess over receipts to be raised by direct taxation in ensuing year.

[2] Paid into town treasury.

1904.—TABLE 3.—STATISTICS OF CONSUMPTION OF WATER.

Number.	Name of city or town.	1	2	3	4	5	6	7	8	9	10	11	12
		Estimated population.						Average consumption. (Gallons per day.)				Cost of supplying water. Per million gallons.	
		Total at date.	On line of pipe.	Supplied at date.	Total consumption for the year. (Gallons.)	Quantity used through meters. (Gallons.)	Percentage of consumption metered.	Total.	To each inhabitant.	To each consumer.	To each tap.	Figured on total maintenance. (Item CC.)	Figured on total maintenance + int'st on bonds.
1	Arlington, Mass.	9 700	9 500	9 400	275 410 000	32 526 630	12	752 567	78	80	420	....	....
2	Atlantic City, N. J.	38 000	37 500	125 000[1]	1 785 564 349	.....	..	4 870 000	128	..	990	$32 59	$72 30
								6 798 000[1]					
3	Attleboro, Mass.	13 500	13 000	....	202 919 700	.....	..	554 513	41	43	....	....	....
4	Bay City, Mich.	29 000	22 000	18 500	1 091 013 061	234 997 513	22	2 980 910	100	161	1 200	14 26	31 15
5	Belmont, Mass.	4 500	4 300	4 100	.....	50 877 000	..	248 800[2]	31[2]	34[2]	207[2]	....	....
								139 300[3]					
6	Billerica, Mass.	2 850	1 900	1 550	36 718 020	.....	..	109 472	..	61	..	78 76	176 18
7	Bridgeport, Conn.	85 000	83 000	82 000	6 385 500 000	1 399 500 000	17	17 500 000	206	213	1 721	....	....
8	Brockton, Mass.	48 000	46 500	43 600	591 371 442	307 668 842	52	1 615 768	34	37	266	....	....
9	Burlington, Vt.	19 700	19 200	19 100	360 312 725	205 935 487	57	987 158	50	51	270	....	....
10	Cambridge, Mass.	97 826	97 826	97 826	3 210 982 145	1 143 795 390	36	8 773 175	90	90	593	21 39	65 95
11	Chelsea, Mass.	36 499	36 499	36 499	1 559 343 000	192 066 032	12	4 260 500	117	117	670	36 53	44 23
12	Cleveland, Ohio	455 000	450 000	444 600	22 535 360 018	8 859 446 640	39	61 572 022	137	138	1 016	16 56	23 19
13	Concord, N. H.	....	17 000	....	.....	.....	..	.....	..	..	..	....	....
14	Fall River, Mass.	113 645	...	112 045	1 497 523 220	.....	..	4 091 593	36	37	..	....	....
15	Fitchburg, Mass.	34 000	...	29 000	1 006 000 000[4]	.....	..	2 750 000[4]	..	95[4]	..	....	....
16	Haverhill, Mass.	39 000	37 500	37 000	1 500 000 000[4]	.....	..	4 109 590[4]	105	111	728	13 86	40 29
17	Holyoke, Mass.	51 406	51 106	50 831	2 664 500 000[4]	498 616 500	19	7 300 000[4]	142	144	1 941	....	....
18	Keene, N. H.	10 000	9 500	9 000	.....	.....	..	.....	..	..	..	....	....
19	Lawrence, Mass.	72 000	...	68 500	1 027 450 650	608 250 750	59	2 814 933	39	42	427	57 79	89 03
20	Lowell, Mass.	104 400	...	104 400	2 007 628 279	875 780 355	44	5 485 323	53	53	486	44 01	66 74
21	Lynn, Mass.	83 500	82 500	82 500	1 952 018 566	550 000 000	25	5 333 384	64	65	365	48 00	100 00
22	Madison, Wis.	21 000	...	20 772	547 834 400	156 931 222	29	1 501 053	52	..	433	....	....
23	Marlboro, Mass.	14 300	13 800	13 200	221 262 300	91 474 500	41	606 198	42	46	262	40 66	134 50
24	Met. W'r Dist., Mass.	927 800	...	....	42 057 180 000	.....	..	114 909 000	124	..	..	....	....
25	Middleboro, Mass., Fire Dist.	7 000	4 200	3 900	93 227 000	42 064 665	45	255 416	61	65	289	....	....
		4 500											
26	Minneapolis, Minn.	240 000	200 000	190 000	6 632 236 620	1 900 000 000	29	18 269 320	77	..	..	....	....
27	Nashua, N. H.	26 000	25 000	25 000	1 076 588 509	.....	..	2 941 499	..	..	..	29 18	....
28	New Bedford, Mass.	73 000	64 000	63 000	2 570 360 614	702 810 000	30	7 001 520	96	111	689	19 07	47 27
29	New London, Conn.	22 000	20 800	20 000	585 600 000	.....	..	1 600 000	78	80	446	17 23	54 65
30	Newton, Mass.	39 100	38 500	38 500									

29	New London, Conn.	22 000	20 800	20 000	585 600 000	.....	..	1 600 000	78	80	446	17 23	54 65	
30	Newton, Mass.	39 100	38 500	38 300	800 888 053	512 000 000	64	2 188 219	56	57	292	....	....	
31	Oberlin, Ohio	4 800	4 000	3 000	60 000 000	29 147 000	49	165 000	34	55	200	$85 70	$115 35	
33	Providence, R. I.	207 900	..	207 900	5 071 693 691	.....	60[4]	13 857 087	67	67	580	....	....	
34	Reading, Mass.	5 000	4 860	4 553	56 279 377	.....	..	154 190	31	34	130	120 37	270 05	
35	Reading, Pa.	88 760	88 500	88 670	4 031 675 218	1 053 737 190	26	11 046 000	124	125	587	14 14	18 03	
36	Somerville, Mass.	71 000	71 000	71 000	2 279 637 000	416 097 066	18	6 228 000	89	89	..	....	....	
37	Springfield, Mass. (incl. Ludlow.)	76 220	75 000	74 916	3 557 520 000	636 850 245	18	9 720 000	128	130	913	....	....	
38	Taunton, Mass.	31 036	28 000	27 500	642 538 734	235 812 251	37	1 755 201	57	64	363	45 85	98 28	
39	Waltham, Mass.	26 600	26 350	26 300	758 640 923	77 121 747	10	2 072 789	78	79	591	40 48	63 70	
40	Ware, Mass.	8 263	7 974	7 850	128 199 820	82 401 541	64	351 232	44	45	432	....	....	
41	Wellesley, Mass.	5 793	5 738	5 700	114 689 955	60 245 923	53	314 219	54	55	331	62 34	160 69	
42	Westerly, R. I.	13 500	12 000	11 000	250 954 400	.....	..	687 500	57	62	449	38 55	87 80	
43	Whitman, Mass.	6 781	...	....	.....	.....	..	.....	..	..	..	....	....	
44	Winchendon, Mass.	5 615	3 400	2 776	32 222 281	15 456 247	48	88 280	16	33	138	125 52	230 21	
45	Woburn, Mass.	14 250	14 200	14 200	520 284 450	67 226 077	13	1 413 108	100	..	468	....	....	
46	Woonsocket, R. I.	36 974	36 474	36 474	399 795 790	299 006 808	75	1 092 338	30	30	413	38 45	134 20	
47	Yonkers, N. Y.	60 000	59 000	59 000	2 023 809 108	1 100 884 303	55	5 529 531	91	94	937	....	....	

[1] In summer. [2] Metropolitan water works measurement. [3] By meters: all services metered. [4] Estimated.

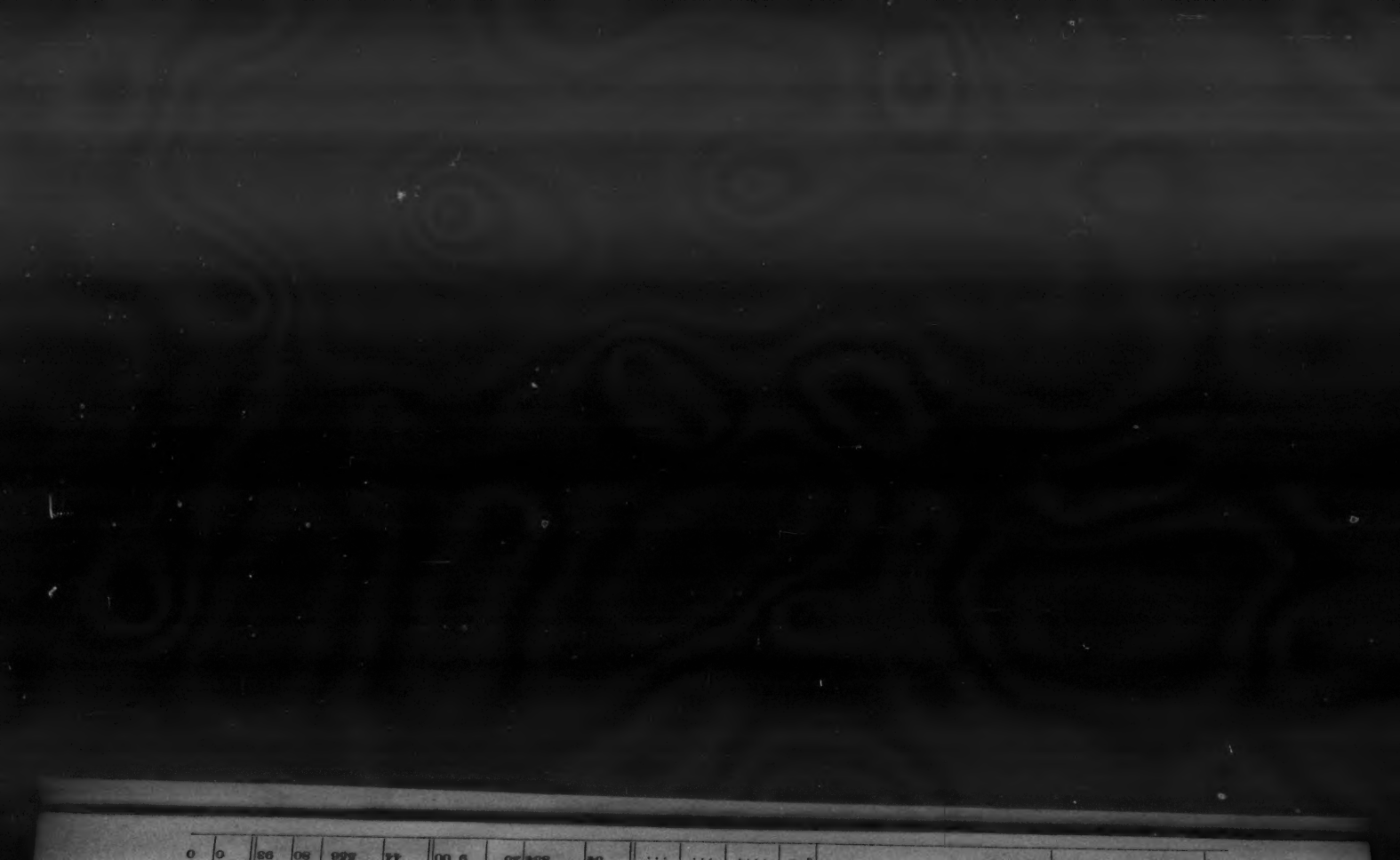
1904.—TABLE 4.—STATISTICS RELATING TO DISTRIBUTION SYSTEM.—MAIN PIPES.

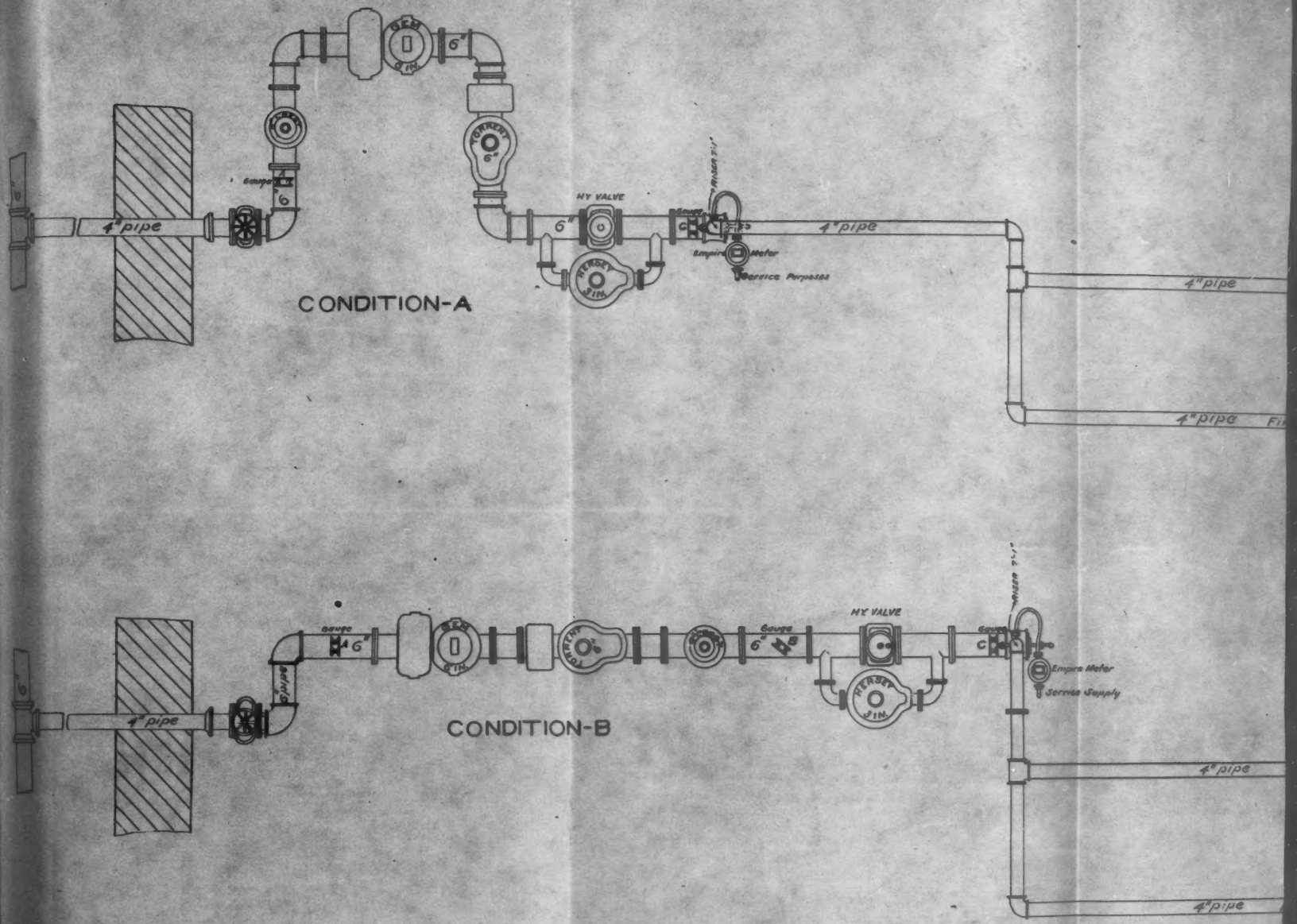
Number.	Name of city or town.	1 Kind of pipe.	2 Sizes of pipes. (Inches.)	3 Length extended during the year. (Feet.)	4 Length discontinued during the year. (Feet.)	5 Total length in use. (Miles.)	6 Cost of repairs. (Per mile.)	7 Number of leaks. (Per mile.)	8 Length of pipe less than 4 in. diam. (Miles.)	9 Hydrants. Number added.	10 Hydrants. Total in use.	11 Gates. Number added.	12 Gates. Total in use.	13 Gates. Number smaller than 4-inch.	14 Gates. Number of blow-off gates.	15 Range of pressure on mains. (Pounds.)
1	Arlington, Mass.	C. I., Cem. L.	4–12	1 838	....	35 5	$5 90	..	0 76	6	357	3	295	....	....	90–50
2	Atlantic City, N. J.	C. I.	4–20	11 365	1 023	60 1	....	..	2 92	13[1]	633[1]	41	....	....	4	40–55
3	Attleboro, Mass.	C. I., Cem. L., W. I.	1–16	6 428	....	44 8	....	0 8	..	6	335	....	....	....	....	54–62
4	Bay City, Mich.	C. I., Wyckoff.	4–20	11 090	9 546	48 4	27 27	1 9	..	8	451[1]	17	774	....	12	35–80
5	Belmont, Mass.	C. I.	4–12	7 663	....	20 1	0	0	0 5	11	158	16	249	21	12	15–100
6	Billerica, Mass.	C. I.	6–12	....	....	9 7	....	2 8	..	..	103	....	84	....	4	54–120
7	Bridgeport, Conn.	C. I., Cem. L.	4–30	14 536	573	143 6	....	..	0	10	682	30	1 440	0	35	30–50
8	Brockton, Mass.	C. I., Cem. L., W. I.	6–30	34 941	270	92 4	3 31	0 3	1 7	34	786	65	1 044	30	44	47–56
9	Burlington, Vt.	C. I., Cem. L., W. I.	4–30	7 901	6 740	40 0	9 53	0 2	3 8	1	216	22	673	66	14	70–85
10	Cambridge, Mass.	C. I.	2–40	1 412	....	125 6	....	17 0	2 0	13[1]	1 018[1]	23	....	0	....	45–55
11	Chelsea, Mass.	C. I.	2–16	792	....	38 7	....	..	0 1	1	299	6	428	0	33	50–75
12	Cleveland, Ohio	C. I.	3–48	83 257	11 903	607 0	11 63	0 4	2 0	207	7 065	396	13 273	6	....	12–63
13	Concord, N. H.	C. I., Cem. L.	4–24	20 923	5 632	65 1	....	..	..	10	292	23	840	....	....	.....
14	Fall River, Mass.	C. I.	6–24	....	....	96 9	....	..	..	31	1 091	41	1 091	....	....	80
15	Fitchburg, Mass.	C. I.	2–30	13 110	....	71 6	....	..	..	44	573	62	643	....	....	155 75
16	Haverhill, Mass.	C. I., Cem. L.	2–24	4 294	....	80 5	....	..	..	2	340	17	848	....	....	30–120
17	Holyoke, Mass.	W. I., C. I., Ld. L.	½–30	1 171	....	85 6	3 12	0 1	5 7	19	815	10	820	15	36	45–100
18	Keene, N. H.	W. I., Cem. L., C. I.	4–24	1 860	....	40 3	2 40	1 7	3 1	6	245	7	390	....	31	55–60
19	Lawrence, Mass.	C. I.	1–30	5 116	2 084	84 7	....	..	7 8	12[1]	790	28	1 103	....	14	65–125
20	Lowell, Mass.	C. I.	4–30	5 706	....	133 7	....	..	2 0	11	1 212	26	1 331	25	34	17–72 L. S.
21	Lynn, Mass.	C. I., Cem. L.	4–36	754	....	135 0	....	1 6	..	2	965	17	1 019	....	66	40–60
22	Madison, Wis.	C. I.	4–8	20 649	....	42 9	....	..	..	36	236	32	307	....	2	53–65
23	Marlboro, Mass.	C. I.	4–16	0	0	36 6	2 62	0 2	0 9	1	347	0	390	19	65	35–142
24	Met. Water Works	C. I., Cem. L.	6–60	....	....	84 2	....	..	..	..	....	3	356	....	....	.....
	Met. Water Dist., (belonging to municipalities)	C. I., Cem. L., Kal.	4–60	....	....	1507 8	....	..	..	178	13 289	..	....	....	....	.....
25	Middleboro, Mass.	C. I.	4–12	542	0	17 3	....	..	0	2	123	2	180	0	6	40–60
26	Minneapolis, Minn.	C. I., W. I., Steel.	6–50	88 933	9 286	301 7	....	0 3	..	173	3 585	147	2 599	....	41	.....
27	Nashua, N. H.	C. I.	4–24	....	....	....	....	..	..	..	250	....	....	....	....	70
28	New Bedford, Mass.	C. I.	4–36	13 758	2 358	102 3	9 50	0 1	0 9	42	1 040	42	1 214	114	101	25–95
29	New London, Conn.	C. I., Cem. L.	4–24	7 377	0	61	$8 32	0 2	16 8	13	337	23	400	....	34	35–45
30	Newton, Mass.	C. I.	4–20	5 560	0	140 2	....	..	..	..	....	....	....	....	....	.....

29	New London, Conn.	C. I., Cem. L.	4–24	7 377	0	61	88 32	0 2	16 8	13	337	23	400	...	34	35–45
30	Newton, Mass.	C. I.	4–20	5 560	0	140 3	1 25	0 03	3 1	4	791	10	829	48	98	80–86
31	Oberlin, Ohio	C. I.	4–12	444	0	10 61	0	0	0 3	1	98	0	67	2	2	27–32
32	Plymouth, Mass.	Cem. L., W. I.	2–20	9 186	5 707	46 5	15 77	1 27	10 3	6	199	27	498	134	37	.....
33	Providence, R. I.	C. I.	6–36	22 767	2 291	345 7	...	0 05	0	42[1]	2 031[1]	68	3 674	0	32	64–73
	H. P. Fire Service	C. I.	12–24	109	....	5 6	...	..	..	0	92	...	31	...	4	114
34	Reading, Mass.	C. I.	6–12	951	0	28 7	1 30	0	0	1	164	1	249	0	14	63–78
35	Reading, Pa.	C. I.	1½–36	8 788	1 627	106 5	9 77	0 7	0 8	18[1]	858[1]	74	2 634	9	...	10–133
36	Somerville, Mass.	C. I.	4–20	5 826	....	89 5	2 53	0 07	..	15	1 033	24	1 343	...	135	35–100
37	Springfield, Mass.	Cem. L., W. I., C. I.	1–36	11 190	1 926	152 2	6 31	0 3	8 2	16[1]	1 016[1]	76	2 129	436	89	30–35 L. S. 90–120 H. S.
38	Taunton, Mass.	C. I.	4–20	1 220	0	80 8	0 21	0 3	1 5	24	837	21	600	12	60	35–120
39	Waltham, Mass.	C. I., Cem. L.	2–24	12 973	11 270	52 8	3 67	0 4	2 1	20	384	19	736	40	60	50–70
40	Ware, Mass.	C. I.	4–12	....	....	12 5	...	..	1	..	120	1	127	13	3	90–95
41	Wellesley, Mass.	C. I., Cem. L.	4–12	2 241	0	31 8	1 12	0 4	0 3	13	303	4	239	3	4	70–75
42	Westerly, R. I.	C. I.	4–16	7 488	0	33 8	...	0 2	..	2	155	7	208	...	8	82–92
43	Whitman, Mass.	C. I., Cem. L.	1–16	....	....	20 8	...	..	..	5	166	16	109	...	...	.....
44	Winchendon, Mass.	C. I., W. I.	2–14	1 921	0	18 2	...	..	1 9	1	142	7	189	29	19	40–151
45	Woburn, Mass.	C. I., Cem. L.	4–14	....	....	54 8	44 16	1 1	5 3	0	361	2	430	55	17	70–75
46	Woonsocket, R. I.	C. I.	4–20	5 572	0	50 0	3 60	0 1	0	15	595	16	501	0	15	50–120
47	Yonkers, N. Y.	C. I.	3–30	11 193	....	93 0	30 90	0 7	0 8	30	967	32	637	3	24	45–130

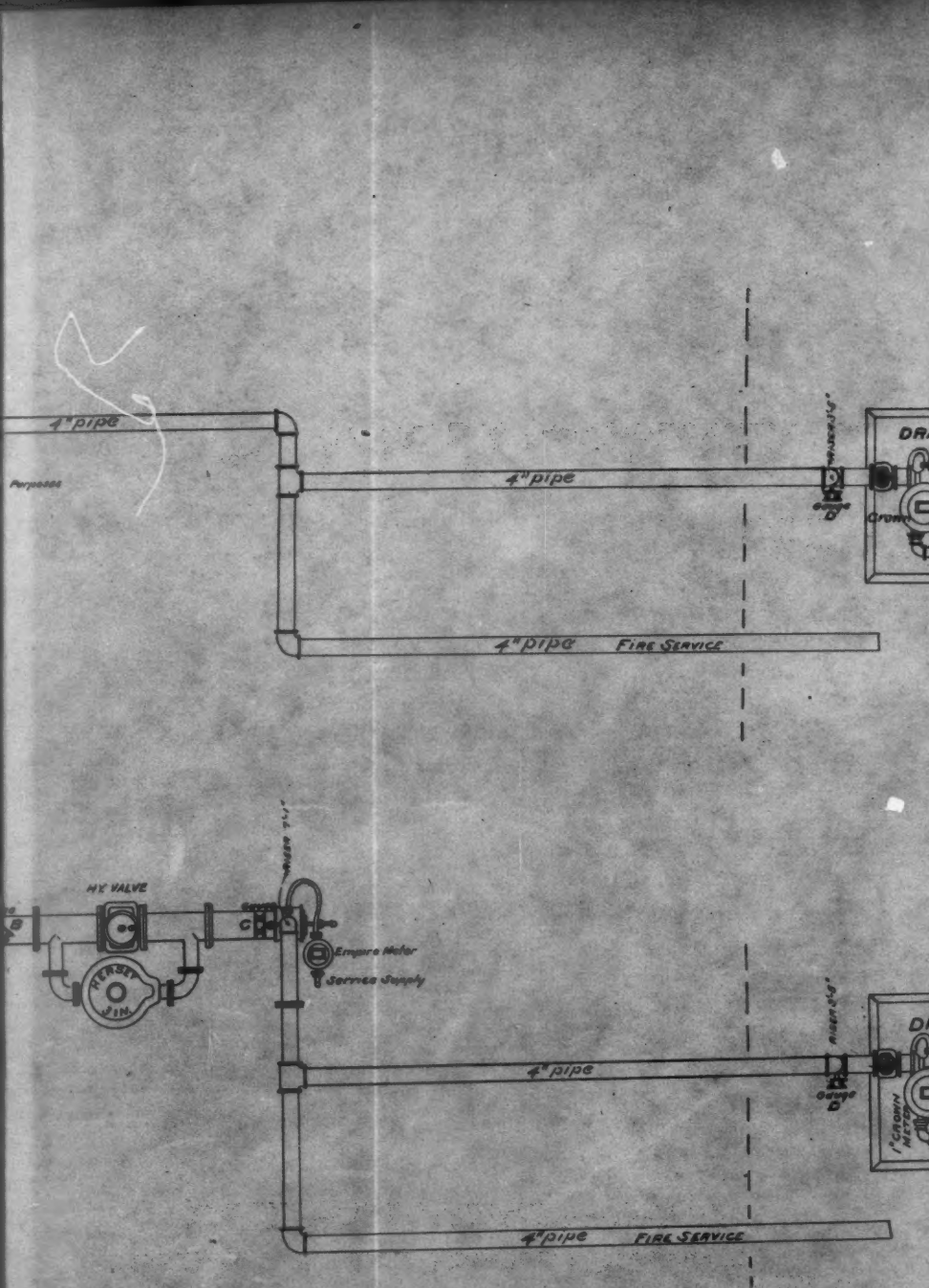
[1] Public hydrants only.

Number.	Name of city or town.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		SERVICE PIPE.					SERVICE TAPS.				METERS.				MOTORS & ELEVATORS.	
		Kind.	Sizes. (Inches.)	Extended. (Feet.)	Discontinued (Feet.)	Total in use. (Miles.)	Number added.	Total in use.	Average length of services. (Ft.)	Average cost of service for the year.	Number added.	Now in use.	Percentage of services metered.	Percentage of receipts from metered water. (B) ÷ (C)	Added.	Total in use.
1	Arlington, Mass.	Cem. Lined, G. I., C. I.	¾–6	....	...	...	37	1 880	..	$22 10	6	116	6	12	..	5
2	Atlantic City, N. J.	Tin Lined, G. I.	¾–4	922	...	...	84	4 903	11	9 80	52	3 981	81	..	..	7
3	Attleboro, Mass.	.....	..	....	...	...	...	.....	..	....	99	1 666	..	..	..	2
4	Bay City, Mich.	Lead, W. I., C. I.	¾–8	....	...	...	79	2 487	..	....	68	1 083	44	64	..	..
5	Belmont, Mass.	W. I., Cem. Lined, G. I.	1–6	1 726	...	6 6	30	673	65 6	24 50	30	673	100	..	..	..
6	Billerica, Mass.	W. I., Cem. Lined.	1–1½	1 336	...	3 6	12	268	71 4	....	9	151	56	70	..	..
7	Bridgeport, Conn.	Lead, W. I.	¾–1	....	....	...	679	10 168	..	....	200	456[1]	..	..	..	..
8	Brockton, Mass.	W. I., Lead Lined, Cem. L., C. I.	¾–8	13 817	1 324	40 8	248	6 097	52 9	12 08	200	5 499	90	97	2	12
9	Burlington, Vt.	Galv. I., C. I., Lead.	¾–6	1 903	500	19 5	56	3 580	25	8 31	90	2 770	..	..	0	35
10	Cambridge, Mass.	Galv. I., C. I.	¾–8	5 737	...	115 2	111	14 803	43	17 69	363	2 596	17	..	..	..
11	Chelsea, Mass.	Lead.	¾–2	1 162	...	32 4	44	6 357	28	17 50	10	126	2	26	0	6
12	Cleveland, Ohio	.....	..	....	....	...	1 775	60 627	16	....	5 196	30 226	49	65	—11	143
13	Concord, N. H.	.....	..	1 303	...	15 2	50	3 458	..	....	65	1 337	39	..	..	..
14	Fall River, Mass.	Lead.	¾–2	....	...	...	165	7 667	..	....	183	7 394	96	..	..	..
15	Fitchburg, Mass.	W. I., Cem. Lined, C. I.	¾–8	....	....	...	73	4 766	..	....	84	2 796	..	..	3	110
16	Haverhill, Mass.	Lead, W. I.	¾–2	2 640	...	43 5	66	5 644	40	16 00	33	688	12	20	..	18
17	Holyoke, Mass.	Cem., Rubber Lnd., Enam., C. I., Ld. Lnd., Tin Lnd., G. I.	¾–4	980	...	14 2	50	3 760	20	15 00	1	248	7	..	3	109
18	Keene, N. H.	W. I., Cem. Lined, G. I., Lead.	¾–6	1 200	...	11 1	30	1 889	..	....	14	120	6	..	..	10
19	Lawrence, Mass.	G. I., Lead, Ld. Lined, C. I.	¾–10	5 089	603	51 0	111	6 581	39 8	21 31	141	5 744	87	93	..	19
20	Lowell, Mass.	Ld., Ld. Lnd., W. I., Tin Lnd.	¾–2	6 638	...	84 4	178	11 287	39 5	27 52	277	7 513	64	79	..	..
21	Lynn, Mass.	Cem. Lined, Ld. Lnd.	¾–4	10 847	418	102	260	13 427	40	18 00	194	3 732	25	23	..	..
22	Madison, Wis.	Lead.	¾–1½	2 807	...	17 2	145	3 462	..	....	160	3 336	97	..	..	..
23	Marlboro, Mass.	Cem. Lnd., Ld. Lnd., Lead, G. I.	¾–2	244	0	9 2	11	2 271	21	12 40	44	1 310	50	69	1	12
24	Met. W'r Dt., Mass.	.....	..	....	....	...	1 343	14[5] 861	..	....	882	15 246	10	..	..	..
25	Middleboro, Mass.	Cem. Lined, W. I., Ld.	¾–2	1 209	0	9 9	16	883	58	....	15	399	45	59	0	7
26	Minneapolis, Minn.	Lead, G. I.	¾–1	....	...	...	...	26 444	..	....	1 954	11 044	42	..	..	8
27	Nashua, N. H.	G. I.	¾–2	....	....	...	....	.....	..	....	....	644	..	..	..	..
28	New Bedford, Mass.	Lead, C. I.	¾–10	12 120	634	67 0	239	10 166	34 8	21 29	191	2 145	21	40	3	135
29	New London, Conn.	Cem. Lined, G. I., Lead.	¾–4	2 631	190	11 2	136	3 589	19 2	11 82	10	288	8	..	0	6
30	Newton, Mass.	G. I., Tarred I., Lead.	¾–6	10 030	3 889	83	82	7 486	59	25 02	114	6 435	86	98	0	17
31	Oberlin, Ohio	G. I., Lead.	¾–4	....	....	...	54	854	25	9 00	44	456	80	93	0	0

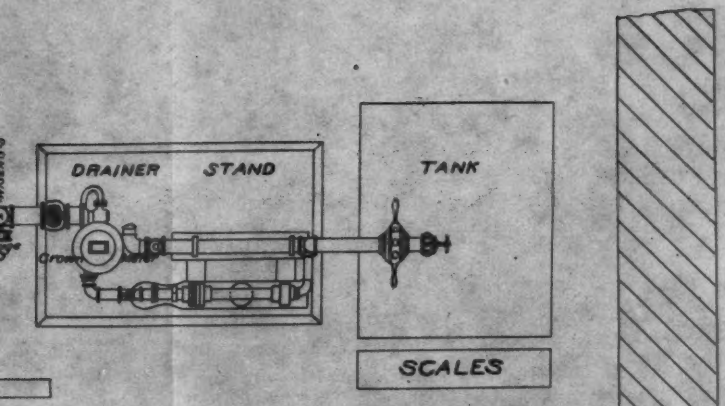




PLAN SHOWING ARRANGEMENTS OF METERS DURING COMPARATIVE TESTS OF 1904.



WING ARRANGEMENTS OF METERS DURING COMPARATIVE TESTS OF 1904.


DRAINER STAND
TANK
SCALES

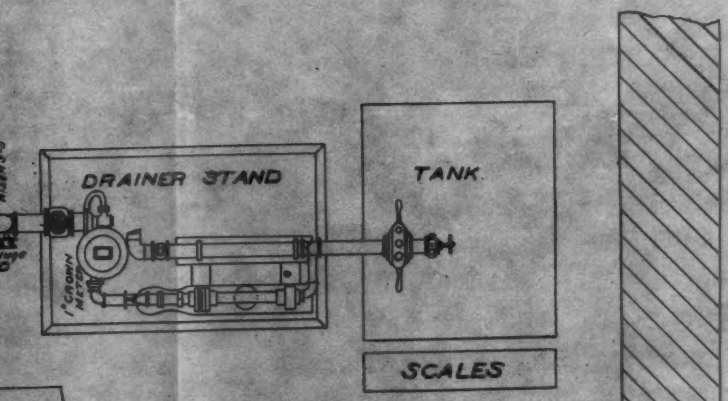

DRAINER STAND
TANK
SCALES

PLATE I.

| | | |

32	Plymouth, Mass.	Lead, Cem. Lined.	½–4	672	...	6	5	41	2 151	16	7	50	..	....	..	..	0	1
33	Providence, R. I.	Lead, C. I.	¾–10	....	...	...		587	23 881	..	....		688	20 489	86	..	5	181
34	Reading, Mass.	Lead, Cem. Lined, C. I.	¾–6	3 477	72	16	0	27	1 189	128	54	66	14	1 049	88	100	..	4
35	Reading, Pa.	Lead, W. I., Ld. Lined, C. I.	½–8	....	...	...		726	18 830	..	....		156	1 293	7	25	2	12
36	Somerville, Mass.	Lead, Ld. Lined, Cem. Lined.	½–6	7 606	...	70	7	201	11 059	..	19	31	624	1 262	11	28	1	10
37	Springfield, Mass.	Ld., Cem. Lined, Tarred Iron, G. I., C. I.	½–6	....	...	...		170	10 641	..	....		189	3 987	..	..	8	288
38	Taunton, Mass.	Cem. Lined, Tin Lined.	¾–3	3 369	...	46	8	73	4 837	..	....		65	2 199	45	66	2	19
39	Waltham, Mass.	W. I., C. I.	¾–12	7 902	2 225	42	7	68	3 508	78	36	40	40	340	10	22	0	10
40	Ware, Mass.	W. I., Cem. Lined.	1–2	1 009	21	10	1	18	816	62	....		19	819	94	100	1	10
41	Wellesley, Mass.	Cem. Lined, Lead Lined, C. I.	½–8	6 106	98	17	4	31	949	185	16	25	42	951	100	100	0	0
42	Westerly, R. I.	Lead, Iron.	½–4	3 155	0	...		73	1 530	43	12	24	91	1 272	83	..	0	11
43	Whitman, Mass.	.....	..	....	...	...		35	1 093	..	....		...	545	..	..	..	..
44	Winchendon, Mass.	W. I.	1–2	1 647	0	5	0	36	569	46	10	50	35	548	97	99	1	1
45	Woburn, Mass.	Lead Lined, Cem. Lined.	1	....	...	...		25	3 021	..	24	12	1	65	2	20	..	9
46	Woonsocket, R. I.	Lead, C. I	⅝–6	1 343	0	7	7	106	2 633	13	12	46	96	2 248	85	96	2	15
47	Yonkers, N. Y.	Lead, C. I.	¾–8	....	...	...		234	5 918	..	....		249	5 891	100	..	..	11

[1]Meters on factories only.

TESTS OF LARGE METERS AND FIRE-SERVICE DEVICES.

BY WILLIAM F. SULLIVAN, ASSISTANT ENGINEER, LOWELL, MASS.

[*Read March 8, 1905.*]

In studying the water statistics of large cities one is compelled to ask himself, "Where does the water go?"

No particular attention was given to answering this question until the advent of water sanitation or until, in many places, the purification of a water supply, or new sources of supply became necessary, with consequent increased cost of maintenance. The installation of more expensive systems has made this question, "Where does the water go?" of much importance to water-works managers and water-works people generally. They have come to see the need of detecting small or large wastes. The first real reform in this direction was the metering of house services.

Cities having a large percentage of small taps metered continued to find a discrepancy between the water recorded and accounted for and the total consumption. This being a fact, the next step was to reach beyond the house meter and place registering apparatus on small and large taps, effectually narrow up the unrecorded wastes and account for all water not actually registered, thus enabling the water department to balance the outgo of water like the wares in any well-regulated business house, where it is realized that care in correcting many small losses, which in the aggregate are excessive, will tend to make the business sure and the profits larger than where no systematic record of profit and loss is kept.

If a leak in a house service or street main is reported it invariably arouses immediate action on the part of the management to correct the defect; if the same management is reasonably certain that hidden wastes occur on fire-service pipes, so called, in mill

yards, into drains, under canals or waterways, in some cases it requires considerable time to get all parties concerned interested and the wastes stopped.

This condition of affairs might have gone on indefinitely but for the agitation which this issue has brought up within a comparatively short time, and which at present is much discussed among the water-works fraternity, underwriters, and fire insurance companies.

The main question appears to be, "Shall all taps and fire-service connections be metered, irrespective of size or condition?"

There seems to be no disposition to object to the placing of meters on domestic, manufacturing or miscellaneous supplies, but when a department proposes to meter a fire service in order to determine whether there are leaks, wastes, or the surreptitious taking of water a protest is generally entered on account of the possibility of such action retarding the flow or entirely shutting off the supply when most needed, and, incidentally, on the part of the water taker, against the cost of such meter.

Lowell is a manufacturing and industrial city, and has at the present time the following number of fire services: 1 1½-inch, 19 2-inch, 48 4-inch, 42 6-inch, 9 8-inch, 2 10-inch, 3 12-inch, a total of 124. Within a few months the water-works department has discontinued 15 12-inch and 2 8-inch fire services. With only one fire service metered (4-inch Crown meter), almost all information is lacking in regard to what water is honestly wasted by curable and incurable leaks, or what is dishonestly taken and used by interests having the special privilege of adequate and copious supplies, in some cases far in excess of other concerns, which in many instances pay as much, if not more, for the maintenance of the water-supply system.

If these particular and amply supplied corporations or individuals with privileged protection are willing to go to considerable expense in complying with underwriters' demands in equipping their plants with outside and inside systems of fire protection, is it too much to have water departments place mechanical watchmen and detectors on the pipe lines and receive compensation for all water used or wasted other than for fire fighting needs? Such a request from a water-works view-point seems reasonable. The

reply from the underwriters to such a request is, generally, "If you place positive meters on fire pipes you jeopardize the risk in case of fire."

If that is so, why not have another service with a meter, or a battery of metered services, so arranged that the meters will record the small flows, and in case of an emergency will supply the required quantity, and by so doing safeguard the interests of all parties concerned? Is it not just that underwriters should eliminate this apprehension and be fair to those who are willing to provide free the means to fight their greatest foe?

The conditions in Lowell, coupled with the present discussion on private fire protection and detection and prevention of water waste, influenced the Lowell water board, after careful consideration, to formulate the following—

REGULATIONS GOVERNING PRIVATE FIRE-SERVICE PIPES.

First. All water for fire-service pipes shall be metered; meter to be furnished and set by city at the owner's expense. No charge shall be made, however, for water used exclusively for the extinguishing of fires.

Second. All main pipes for fire services shall be furnished and connected by the city at the expense of the owner.

Third. Where a standpipe, tank or cistern is used it shall be constructed in such a manner as to shield and protect the water from all possible pollution.

Fourth. Provision shall be made in its construction for means of access to the interior of it by the superintendent or other agents of the water department for the purpose of inspection, and so as to allow for its cleaning as required by the water department.

Fifth. It shall also be fitted with a pipe for the purpose of drawing off all the water at such intervals as required by the water department.

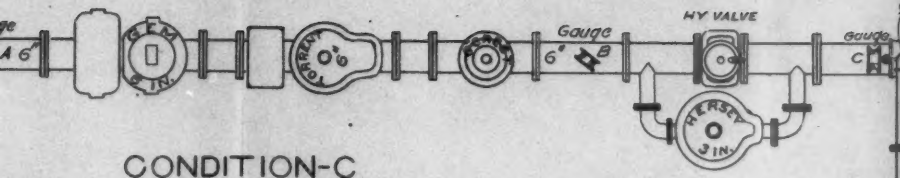
Sixth. Said draw-off pipe must not be connected with a sewer or drain in a way that might lead to the contamination of the water from such source.

Seventh. All expenses not mentioned herein incurred on account of fire services shall be borne by the corporation, firm or individual owning the protected premises.

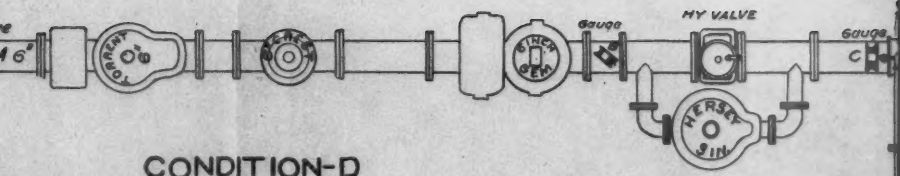
Eighth. The water board shall have the power from time to time to prescribe whatever other rules they may deem necessary.

6"
4" pipe
6" pipe
Gauge
1 6"

6"
4" pipe
6" pipe
Gauge
1 6"

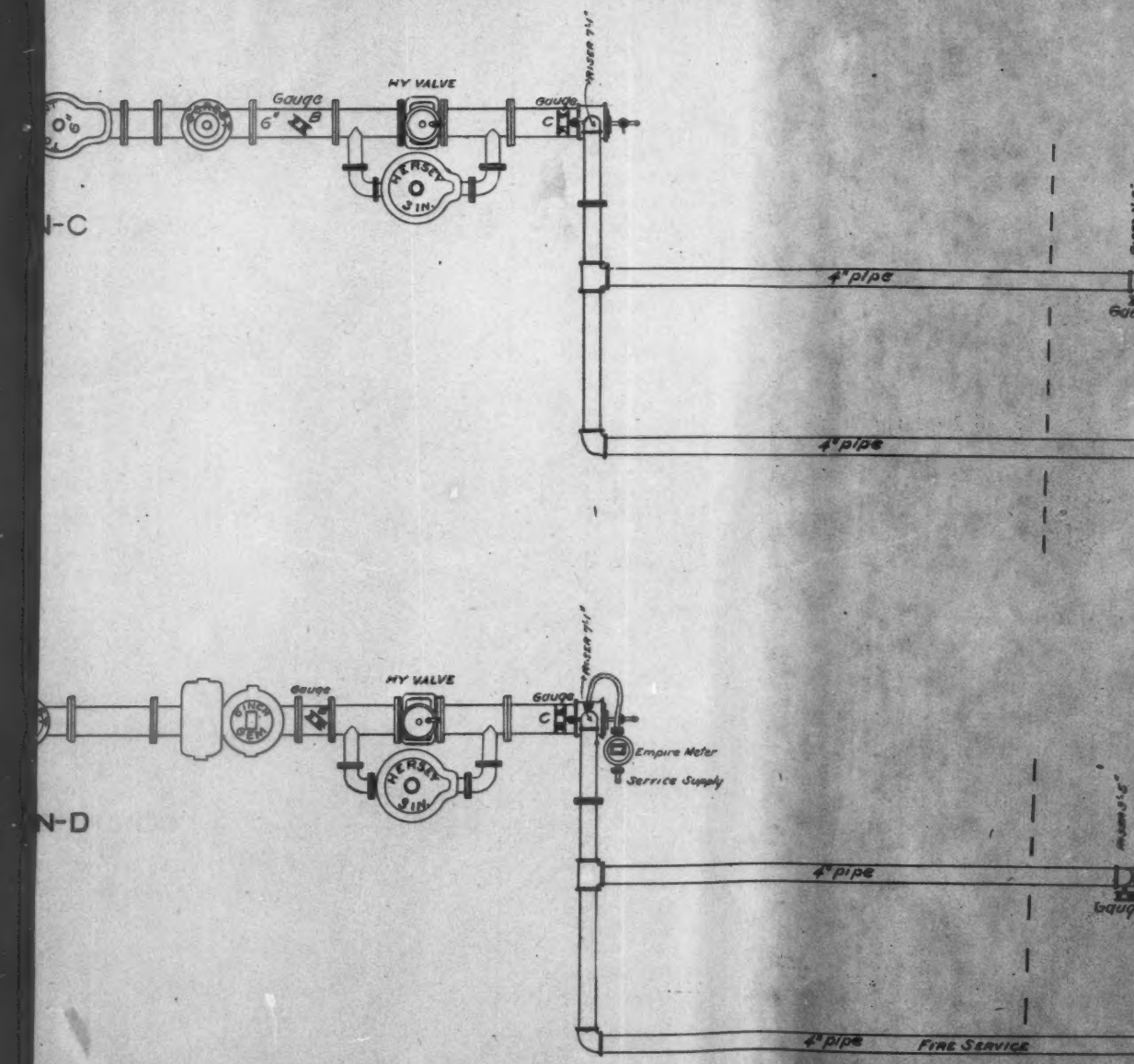


CONDITION-C

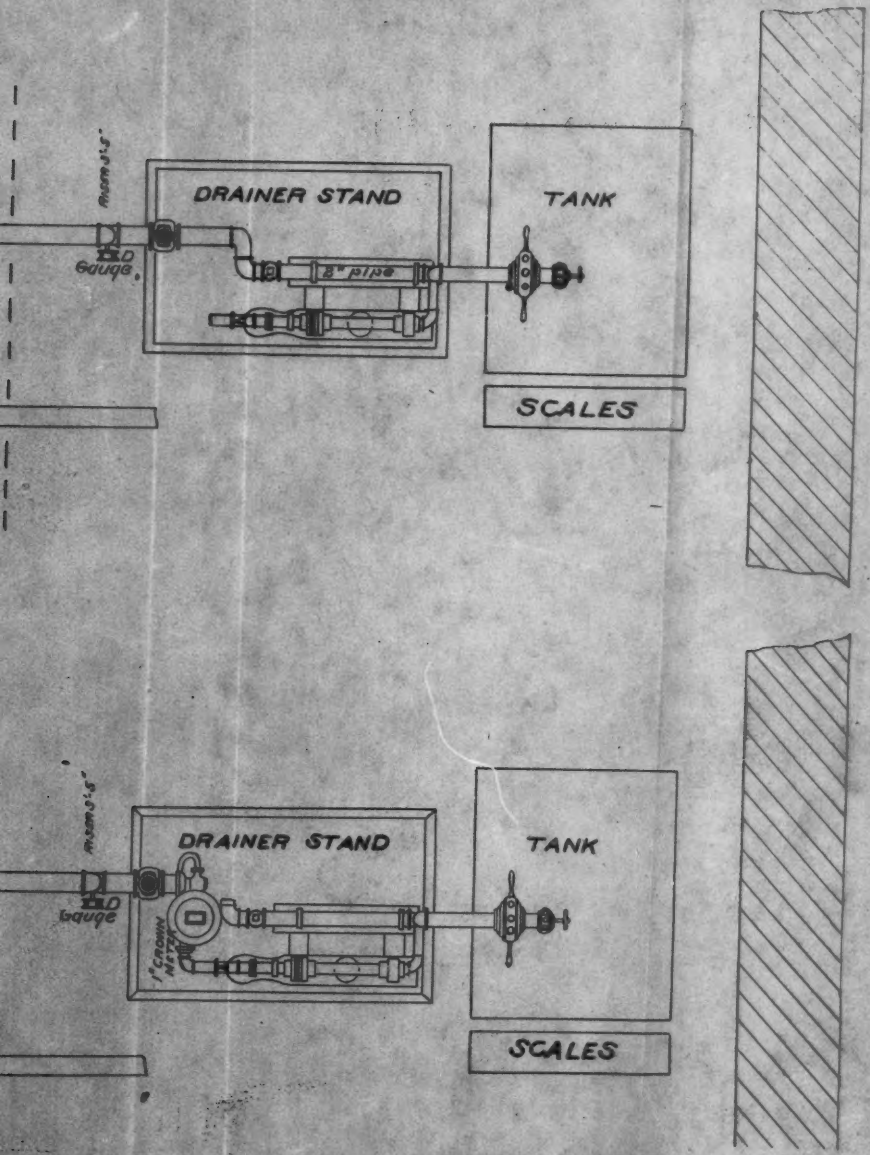


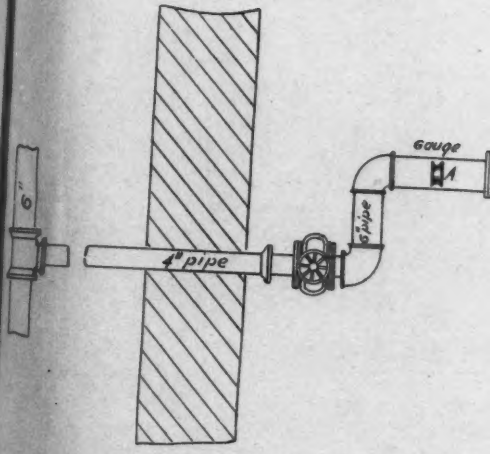
CONDITION-D

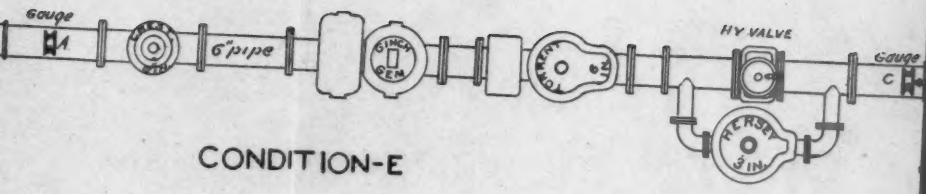
PLAN SHOWING ARRANGEMENTS OF METE



PLAN SHOWING ARRANGEMENTS OF METERS DURING COMPARATIVE TESTS OF 1904.

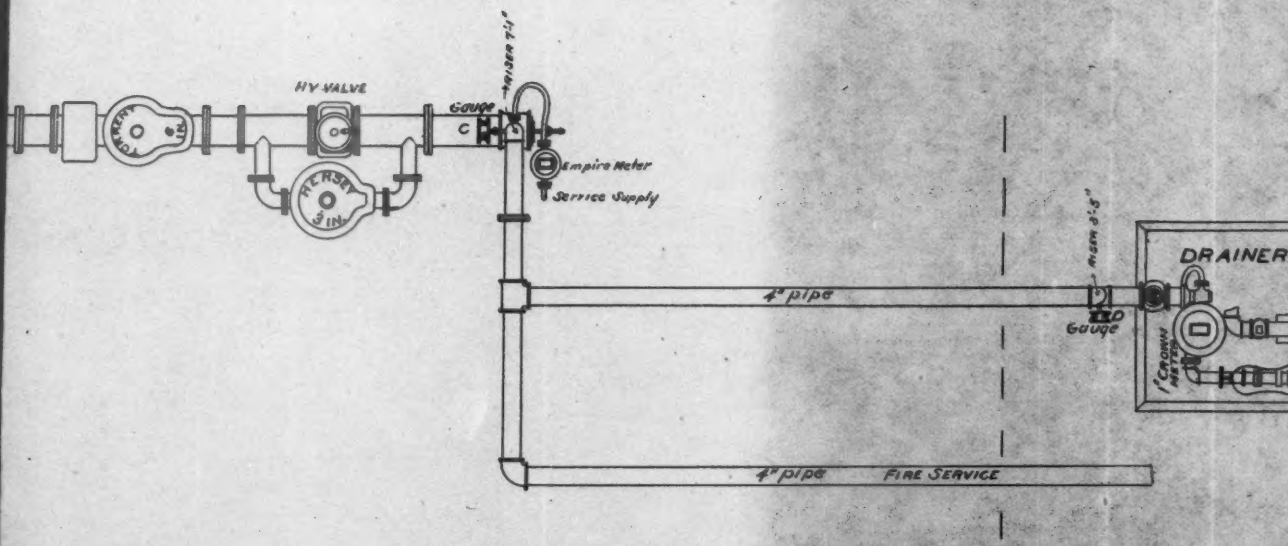

DRAINER STAND
TANK
2" pipe
SCALES
DRAINER STAND
TANK
SCALES


6"
4" pipe
Gauge
1
6" pipe



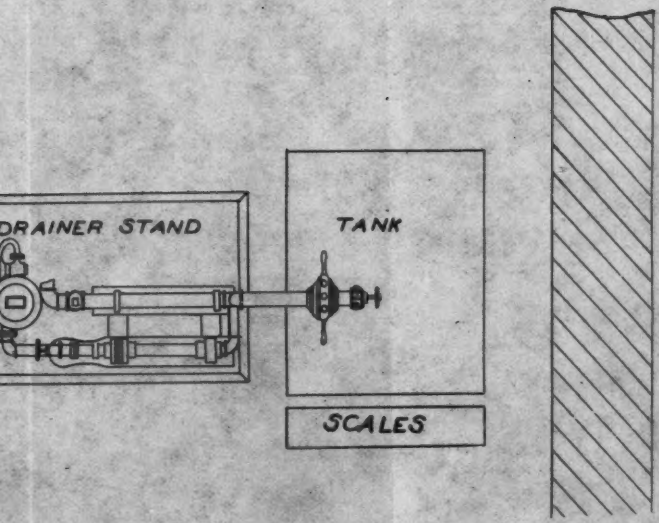
CONDITION-E

PLAN SHOWING ARRANGEMENT OF MET



PLAN SHOWING ARRANGEMENT OF METERS DURING COMPARATIVE TESTS OF 1904.

PLATE III.



The water board, having determined that water for fire-service supplies shall be metered, decided to investigate and find, if possible, the relative merits and comparative worth of different types of large meters or devices, with respect to their local applicability under varying conditions, the sensitiveness, accuracy, and loss of pressure due to the meter, or any other unusual or special characteristics, either favorable or unfavorable, for the uses for which such meters were designed; to determine also their reliability as detectors of small or large wastes, and their capability of passing the maximum quantity of water with the least retardation consistent with the type of meter; to endeavor to find a meter least liable to clog and stop when most needed to perform its work, to obtain a meter or measuring device having the essentials of simplicity, solidity, and durability, a meter that can be easily inspected, cleaned, and repaired; in short, to obtain the information necessary to guide the department in selecting the meters or devices suited to the particular work required.

The available data was not sufficient to instruct the water board or property owners in adopting any particular type of meter or device, as it is only quite recently, probably on account of the discussion among water-works people for large-sized meters, that some of the meter companies have been aroused to an increased activity and consequent keener competition in the manufacture and sale of large meters.

The testing of small or house meters by water departments has long been a custom, and the importance and necessity of such testing should make it as unlimited in its scope as is the law of having a sealer of weights and measures in every city and town to examine and stamp his seal of approval on every scale and measure, large or small, within his jurisdiction.

Then why do water departments and meter manufacturers limit testing to small meters, and test large meters on small flows only? Is it not of equally great importance where large meters are needed and used that something should be known of their performance and correctness, and that they should not be purchased, accepted, and installed on mere recommendation of a meter manufacturer, who will tell you, in most cases, that the large meters have been tested on small flows, and the meter is

supposed to be correct for larger flows because it is a larger pattern of the smaller models?

Having decided to get at the facts, our superintendent, Mr. R. J. Thomas, invited the manufacturers to submit different types of meters and devices to be tested, to enable us to observe their action. After the meters were delivered, the query was, how to obtain the desired information. Lowell, like similar water departments, had apparatus and facilities for testing small meters, and large meters on small flows. Not having better facilities at hand, and fully understanding that such tests would be incomplete and inconclusive, we decided, for a more complete test with the facilities at hand, to vary the usual test of separate meters by connecting them in series, and getting the comparative results.

The meters were set on the basement floor and near the small testing rig. The water for the tests was supplied through a 4-inch pipe used for fire service and testing purposes, and fed by a 6-inch street main, about 25 feet from the building, the street main in turn being supplied from a 12-inch distribution pipe direct from the low-service reservoir, ensuring a constant and steady supply.

The first arrangement, or condition A (as shown, Plate I), was made up of three current meters, a 6-inch Crest, 6-inch Gem and 6-inch Torrent, forming the letter U. On the outlet side was placed a 6-inch Tilden's device with 3-inch Hersey disc meter on by-pass; from the outlet end of this device a 4-inch riser was run to the testing apparatus for small meters. On this riser was tapped a connection for supplying the shop through a ¾-inch Empire meter with water for ordinary purposes, such as the intermittent use of water for two sinks, two water-closets, and one washstand. During the time the shop was getting its supply from this source the regular service supply was cut off, and the water used for testing small meters at the weighing tank was checked and recorded by a 1-inch Crown meter. As the test proceeded it was found that the 3-inch Hersey disc was a close registering meter and agreed with the amount of water recorded by both the ¾-inch Empire and 1-inch Crown. While testing the current meters for sensitiveness and accuracy on different sized streams through the multiple

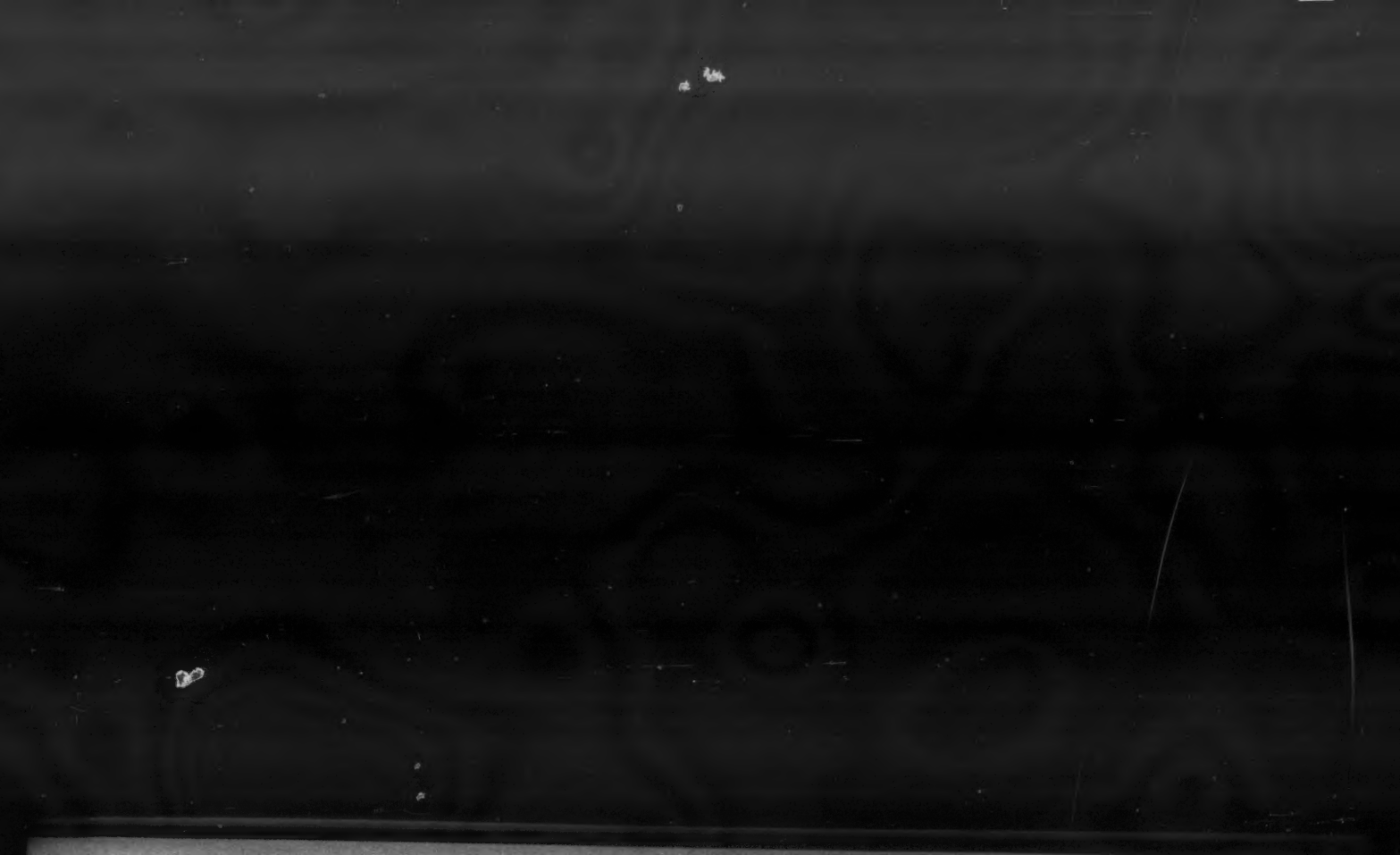
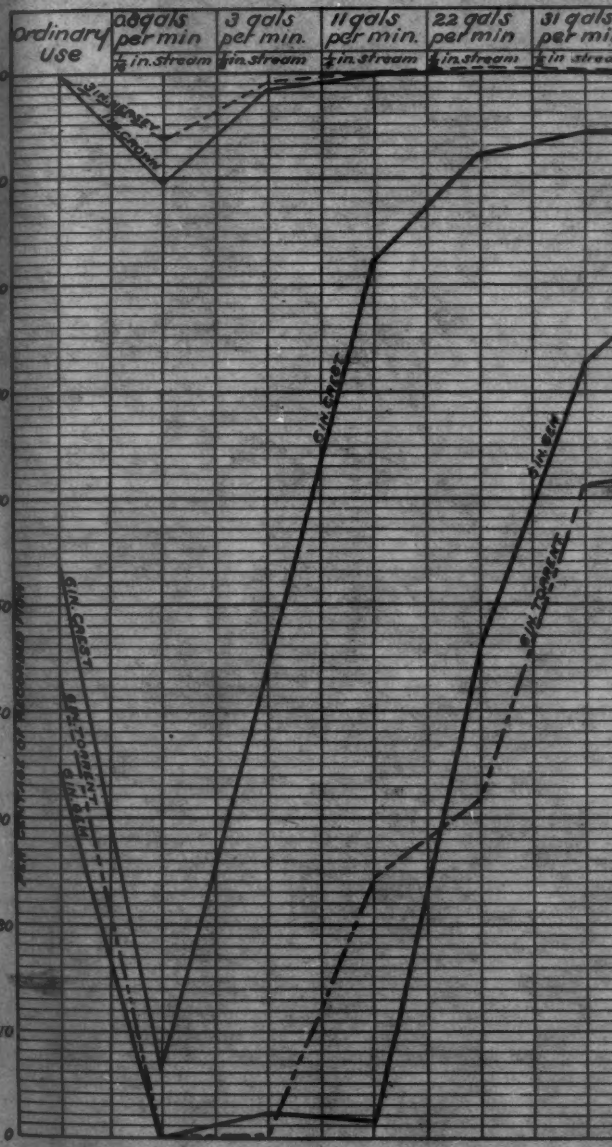
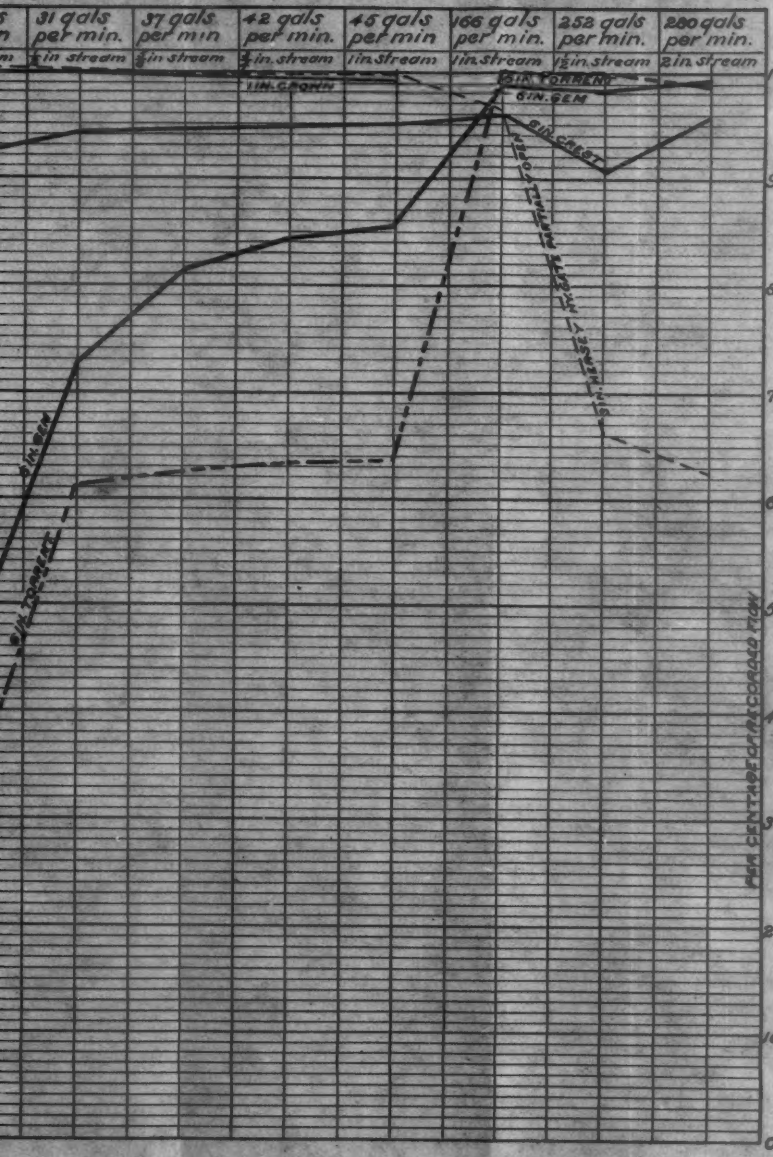


DIAGRAM OF


Ordinary use
8 gals per min
3 gals per min.
11 gals per min.
22 gals per min
31 gals per mi
1/8 in. Stream
1/4 in. Stream
1/2 in. Stream
3/4 in. Stream
1 in. Stream
100
90
80
70
60
50
40
30
20
10
0
6 IN. CREST
6 IN. CREST
6 IN. CREST

M OF RECORDED FLOW



COMPA

Size of Meters	Meters	Ordinary Use				
		Recorded Flow		Unrecorded Flow		
		By Weight cu ft	By Meter cu ft	Cubic feet	Per cent.	Discharge gal. per min.
¾"	Empire	13471	13471	0.0	0.0	
1"	Crown					
3"	Hersey	13471	13390	81.0	0.6	
6"	Crest	13471	456	13015	96.61	
6"	Torrent	13471	12595	876.	6.50	
6"	Gem	13471	11900	1571.	11.66	

Note: The meter flows; found his statement parts of the m a meter. Bef taken that nor The question The following

Size of Meters	Meters	⅛ inch Opening					¼ inch Opening					½ inch O				
		Recorded Flow		Unrecorded Flow		Discharge gal. per min.	Recorded Flow		Unrecorded Flow		Discharge gal. per min.	Recorded Flow				
		By Weight cu ft	By Meter cu ft	Cubic feet	Per cent.		By Weight cu ft	By Meter cu ft	Cubic feet	Per cent.		By Weight cu ft	By Meter cu ft	Cubic feet	Per cent.	
¾"	Empire															
1"	Crown	249.9	238	11.9	4.8	.80	964.5	939	25.5	2.6	2.96	1380	1380			
3"	Hersey	249.9	238	11.9	4.8	.80	964.5	952	12.5	1.3	2.96	1380	1374			
6"	Crest	249.9	9	240.9	96.4	.80	964.5	306	658.5	68.3	2.96	1380	1155			
6"	Torrent	249.9	0	249.9	100.	.80	964.5	15	949.5	98.4	2.96	1380	1026			
6"	Gem	249.9	0	249.9	100.	.80	964.5	29.5	935.	96.9	2.96	1980	43			

*over-registration

IPARATIVE TEST OF MET

CONDITI

e meters were arranged as per Condition A. (See Sket
ound that Crest meter failed to register. Notifie
ment, to find sufficient cause for the stoppage. S
the meter, but was considered by those conducti
Before the stoppage a half inch hole had been
at none of the drillings should get into the pipe; n
tion whether the sediment, drillings, or other obstruc
owing tables show the registration and perform

CONDITIO

½ inch opening					⅝ inch opening					½ inch opening					⅝ inch opening					¾ inch opening				
Recorded Flow		Unrecorded Flow		Stoppage	Recorded Flow		Unrecorded Flow		Stoppage	Recorded Flow		Unrecorded Flow		Stoppage	Recorded Flow		Unrecorded Flow		Stoppage	Recorded Flow		Unrecorded Flow		Stoppage
By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per Cent	in minutes	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per Cent	in minutes	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per Cent.	in minutes	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per Cent.	in minutes	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per Cent.	in minutes
80	1380	0.0	0.0	10.71	2892	2892	0.0	0.0	23.69	3892	3675	7.0	0.18	30.68	4766	4740	26	0.54	37.71	750	745	5.0	0.6	
80	1374	6.0	0.43	10.71	2892	2902	*10.0	*0.34	23.69	3892	3887	*5.0	*0.13	30.68	4766	4758	8	0.17	37.71	750	747	3.0	0.4	
80	1155	225	16.3	10.71	2892	2686	206	7.12	23.69	3892	3651	2.31	5.95	30.68	4766	4439	267	5.60	37.71	750	710	40.0	5.3	
80	1026	354	25.68	10.71	2892	2687	205	7.09	23.69	3892	36.92	190	4.89	30.68	4766	4608	158	3.31	37.71	750	729	21.0	2.8	
80	43	1337	96.9	10.71	2892	1615	1277	44.15	23.69	3892	2779	1103	2841	30.68	4766	3862	904	18.96	37.71	750	621	129.	17.2	

OF METERS CONNECTED I

CONDITION-A

ion A. (See Sketch). After thoroughly flushing meters with
ister. Notified the makers; their agent inspected
e stoppage. Several ounces of soft slimy sedime
se conducting the test as insufficient to derang
ole had been drilled and tapped on pipe line to con
to the pipe; none were found. at the time the meter
r other obstruction caused the stoppage remains u
and performance since the examination and clean

CONDITION-B

Outlet same as Condition C

pening			½ inch Opening					1 inch Opening					1 inch Opening					½ inch Opening					2 inch
Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow
Cubic Feet	Per cent.	Adopted Flow	By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per cent	Adopted Flow	By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per cent	Adopted Flow	By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per cent.	Adopted Flow	By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per cent	Adopted Flow	By Weight Cu.ft.
26	0.54	37.71	750	745	5.0	0.66	42.74	1535	1526	9.0	0.58	45.31											
8	0.17	37.71	750	747	3.0	0.40	42.74	1535	1534	1.0	0.06	45.31	103	100	3	2.91	167.38	74	50	24	32.43	256.2	
67	5.60	37.71	750	710	40.0	5.33	42.74	1535	1455	80.0	5.21	45.31	103	100	3	2.91	167.38	74	67½	6.5	8.78	256.2	
58	3.31	37.71	750	729	21.0	2.80	42.74	1535	1499	36.0	2.34	45.31	103	105	*2	1.94	167.38	74	76½	*2.5	*3.37	256.2	
04	18.96	37.71	750	621	129.	17.20	42.74	1535	1287	248	16.16	45.31	103	103	0	0	167.38	74	73½	0.5	0.87	256.2	

Note: 6" Hy. Gate on Tilden's Contrirance slightly jarred from seat.

Note: 6" Hy. Gate on Tilden's Contrirance opened ½ inch Loss of head 1116 s

) IN SERIES.

with large streams, began test on small
ed the meter and failed, according to
ment had accumulated on the working
ange, in any way, the proper working of
connect a pressure gauge, care being
ter was opened and examined.
s unanswerded.
eaning of the Crest meter.

2 inch opening						Ordinary Use						
Recorded Flow		Unrecorded Flow			Gallons discharged per minute	Recorded Flow		Unrecorded Flow			Gallons discharged per minute	Remarks
By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent.			By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent			
						3498	3497	0.0	0.0			Oscillating Piston Meter
												Rotary Piston Meter
						3477	3476	1.0	0.03			Disc Meter
						3477	2436	1041	29.9			Current Meter
						3477	2175	1302	37.4			Current Meter
						3477	1315	2162	62.1			Current Meter

cock and weighing the discharge in the tank, the shop was supplied by its own service.

Under the "ordinary-use" test, we undertook to find which of the current meters would show the largest percentage of registration under conditions similar to those met with in practice where water is used, or wasted through carelessness or otherwise.

On testing for sensitiveness on 1–16-inch to ¼-inch streams, requiring considerable time for the registering hands to make complete revolutions on the dial, so as to eliminate any error due to the adjustment of the index hands, the apparatus could be set in operation and allowed to run unattended for hours or days, and by careful timing, gaging of discharges before and after each test, and also comparing the check meters, very accurate results were obtained.

Before beginning the series test the meters were thoroughly flushed through a 2-inch opening; the first meter on the line failed to register; an inspection showed that several ounces of soft, slimy sediment had accumulated on the working parts of the meter, but this was considered insufficient to derange in any way the proper working of this type of meter. Shortly before the meters were flushed a half-inch hole was drilled and tapped on inlet side of meter to connect pressure gage, care being used that none of the drillings should get into the meter. None were found at the time the meter was opened and examined. This failure to record brought up the question, — Did position in the arrangement or line have any effect on registration? Some meter men, owing to a lack of better information, were inclined to believe it to be so.

To satisfy some of the meter men and gather information on this point, a new arrangement and alignment of the meters was made, the meters being made interchangeable by fitting with nipples and uniform flanges. The meters were then successively tested under conditions B, C, D, E. (See Plates I, II, III.)

During a portion of the test under condition E, it was found that small rates of flow through one of the current meters did not cause any movement of the register until the 1-inch stream with sufficient water pressure to overcome the adhesion set it in motion.

We tried repeatedly afterwards to obtain like results on small streams, but on each occasion the meter registered.

After obtaining considerable practical information with the facilities limited to a 2-inch opening on the multiple cock, inadequate drainage for larger flows and a small weighing tank, we fully realized that to make more complete tests some other arrangement would be necessary.

Plates I, II, and III show the different arrangements of meters during the series tests.

On Plate IV is graphically shown the average recorded flow of the meters under different conditions and different rates of discharge.

On Plates V, VI, and VII are shown in tabulated form the results of the comparative tests of meters connected in series.

In studying the best methods of measuring the flow of water and checking the registration of meters, the nozzle seemed to be best adapted for such work and could readily be employed as a practical check meter; we felt fully convinced that Mr. John R. Freeman's experiments with nozzles were conclusive. As Mr. Freeman says, "The nozzle will, I think, on reflection, be granted to be the most portable and compact gaging apparatus in proportion to its capacity which has ever been devised for such purposes."

To give further confidence in the use of the nozzles, Mr. Freeman asked himself the question, "Is any accidental variation in method of setting up liable to introduce a change of rate or error in its indication while using the coefficient as previously determined once for all?" In answer to his own question, he says, "In the subsequent use of this particular piece of apparatus, we may (if our pressure gage is all right and the apparatus set up in almost any reasonable manner) have the greatest confidence that the error of any series of measurements would not exceed one half of one per cent."

The expense of such installation is not prohibitive; quoting Mr. Frank C. Kimball, "As the expense of installing a permanent testing plant for large meters is not great, comparatively speaking, by the installation of such testing plants in several of the larger cities there would result, in our opinion, a toning up, as it were, of

No.	Types of Meters
1	E
2	C
3	H
4	C
5	T
6	G

No.	Meters
1	En
2	Cr
3	He
4	Cr
5	To
6	Ge

CONDITION

Meters	1/16 inch opening					1/8 inch opening					1/4 inch opening					3/8 inch opening					1/2 inch opening					5/8 inch opening					3/4 inch opening				
	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.
	By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.	
1" Empire																																
1" Crown	97	85	12	12.37	.80	384	376	8.0	2.08	3.06	1435	1434	1.0	0.07	11.29	2678	2678	0.0	0.0	21.55	3908	3908	0.0	0.0	31.41	621.5	619	2.5	0.40	36.85	654	650	4.0	0.6
3" Hersey	97	91	6	6.16	.80	384	384	6.0	1.56	3.06	1435	1435	0.0	0.0	11.29	2678	2698	*20.	*0.74	21.55	3908	3924	*16.	*0.4	31.41	621.5	622	*0.5	*0.08	36.85	654	654	0.0	0.0
6" Crest	97	8	89	91.75	.80	384	164	220	31.25	3.06	1435	1183	252	17.56	11.29	2678	2376	300	11.20	21.55	3908	3684	224	5.73	31.41	621.5	588	33.5	5.39	36.85	654	621	33.	5.04
6" Torrent	97	00	97	100.	.80	384	2	382	99.47	3.06	1435	4	1431	99.72	11.29	2678	25	2653	99.06	21.55	3908	3455	453	11.59	31.41	621.5	567	54.5	8.76	36.85	654	607	47.	7.18
5" Gem	97	00	97	100.	.80	384	12	372	96.87	3.06	1435	12	1423	98.16	11.29	2678	1009	1669	62.32	21.55	3908	2867	1041	26.63	31.41	621.5	515	106.5	17.13	36.85	654	560	94	14.37

*Over-registration

CONDITION

Meters	1/16 inch opening					1/8 inch opening					1/4 inch opening					3/8 inch opening					1/2 inch opening					5/8 inch opening					3/4 inch opening				
	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.	Recorded Flow		Unrecorded Flow		Discharge per min.
	By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.		By Weight cu. ft.	By Meter cu. ft.	Cubic Feet	Per Cent.	
1" Empire																																
1" Crown	101	87	14	13.86	.80	394	392	2	0.50	3.07	1409	1409	0.0	0.0	11.25	2720	2720	0.0	0.0	21.47	3887	3881	6.0	0.15	31.31	653	650	3	0.46	36.77	935	930	5	0.53
3" Hersey	101	93	8	7.92	.80	394	395	*1	*0.25	3.07	1409	1411	*2.0	*0.14	11.25	2720	2735	*15.0	*0.55	21.47	3887	3884	3.0	0.08	31.31	653	652	1	0.15	36.77	935	933	2	0.21
6" Crest	101	7	94	93.06	80	394	135	259	65.73	3.07	1409	1143	266.	18.80	11.25	2720	2581	139.	5.11	21.47	3887	3682	205	5.27	31.31	653	620	33	5.05	36.77	935	889	46	4.92
6" Torrent	101	0	101	100	.80	394	0	394	100.	3.07	1409	0	1409	100.	11.25	2720	55	2665	97.97	21.47	3887	0	3887	100.	31.31	653	0	653	100.	36.77	935	0	935	100.
5" Gem	101	0	101	100	80	394	6	388	98.47	3.07	1409	20	1389	98.58	11.25	2720	1250	1470	54.04	21.47	3887	2876	1011	26	31.31	653	527	126	19.29	36.77	935	797	138	14.75

*Over-registration

Note: Torrent Meter stopped

Note. — During a part of the test under Condition E (see sketch), the 6-inch Torrent meter was blocked by a small quantity of sediment that pocketed in depression of the deflector where the bottom of bushing rotates on the spindle. After completion of the test a representative of the Hersey Manufacturing Company cleaned and smoothed bushing and spindle. At a subsequent test the meter showed about the same percentage of registration as before the stoppage.

At the conclusion of the test the 6-inch Gem meter was examined and cleaned by an inspector from the National Meter Company. He considered the meter in good condition, except "that the rubber bushing had expanded somewhat closer to the bearing since the meter was adjusted at the factory, due to the difference of temperature." He smoothed the spindle and slightly rebored the bushing. The meter recorded about the same amount of flow as before the inspection.

CONDITION-D

K Outlet same as Condit

ening			⅛ inch Opening					¼ inch Opening					½ inch Opening					1 inch Opening					1½ inch Opening					2i
Recorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Re
ic ft	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Wei cu.f
.0	0.0	31.41	521.5	619	2.5	0.40	36.85	654	650	4.0	0.6	42.31	311	308	3.0	0.96	44.55											
5.	*0.4	31.41	521.5	622	*0.5	*0.08	36.85	654	654	0.0	0.0	42.31	311	310	1.0	0.32	44.55	87	85	2.0	2.29	166.	77	48.5	28.5	37.01	252	7
4	5.73	31.41	521.5	588	33.5	5.39	36.85	654	621	33.	5.04	42.31	311	295	16.0	5.14	44.55	87	85	2.0	2.29	166.	77	68	9.0	11.69	252	7
3	11.53	31.41	521.5	567	54.5	8.76	36.85	654	607	47.	7.18	42.31	311	291	20.0	6.43	44.55	87	86	1.0	1.14	166.	77	77	0.0	0.0	252	7
1	20.63	31.41	521.5	515	106.5	17.13	36.85	654	560	94	14.37	42.31	311	270	41.0	13.15	44.55	87	86	1.0	1.14	166.	77	72	5.0	6.5	252	7

Note: 6" Hy. Gate on Tilden's contrivance slightly jarred from seat.

Note; 6" Hy. Gate on Tilden's Contrivance opened ½ inch Loss of pressure 1116

CONDITION-E

K Outlet same as Condition

ening			⅛ inch Opening					¼ inch Opening					½ inch Opening					1 inch Opening					1½ inch Opening					2i
Recorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Recorded Flow		Unrecorded Flow			Re
ic ft	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Weight cu.ft.	By Meter cu.ft.	Cubic Feet	Per cent.	Discharge per min.	By Wei cu.f
0	0.15	31.31	653	650	3	0.46	36.77	935	930	5	0.53	41.78	626	626	2	0.31	43.93											
0	0.08	31.31	653	652	1	0.15	36.77	935	933	2	0.21	41.78	626	626	2	0.31	43.93	76	73	3	3.94	165.61	72	49	23	31.94	2486	74
5	5.27	31.31	653	620	33	5.05	36.77	935	889	46	4.92	41.78	626	599	29	4.61	43.93	76	71	5	6.58	165.61	72	67	5	6.94	2486	74
7	100.	31.31	653	0	653	100.	36.77	935	0	935	100.	41.78	626	0	626	100.	43.93	76	76	0	0.0	165.61	72	70	2	2.77	2486	74
1	26	31.31	653	527	126	19.29	36.77	935	797	138	14.75	41.78	626	543	83	13.55	43.93	76	74	2	2.63	165.61	72	73	* 1	1.39	2486	74

Note: Torrent Meter started. 6" Hy. Gate on Tilden's contrivance slightly jarred and opened.

Note; 6" Hy. Gate on Tilden's Contrivance opened ½ inch. Loss pressure 1116

ll quant of ty
of the test a
meter showed

ter Company.
nce the meter
. The meter

Condition C

ning		2 inch Opening						Ordinary use					Remarks
		Recorded Flow		Unrecorded Flow				Recorded Flow		Unrecorded Flow			
		By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent.	Discharge per minute		By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent.	Discharge per minute	
								785	780	5.0	0.62		Oscillating Piston Meter
													Rotary Piston Meter
7.01	252	73	45	28	38.35	284		785	784	1.0	0.12		Disc Meter
1.69	252	73	70	3	4.10	284		785	521	264	33.63		Current Meter
0.0	252	73	70	3	4.10	284		785	110	675	85.97		Current Meter
6.5	252	73	72	1	1.37	284		785	103	682	86.87		Current Meter

Note: 6" Hy. Gate on Tildens Gate on entrance opened 2 inch
Loss of pressure 12 lbs

Condition C

ing		2 inch Opening						Ordinary use					Remarks
		Recorded Flow		Unrecorded Flow				Recorded Flow		Unrecorded Flow			
		By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent.	Discharge per minute		By Weight Cu.ft.	By Meter Cu.ft.	Cubic Feet	Per Cent.	Discharge per minute	
								756	756	0.0	0.0		Oscillating Piston Meter
													Rotary Piston Meter
94	2486	74	47	27	36.48	275.53		756	750	6.0	0.79		Disc Meter
04	2486	74	71	3	4.05	275.53		756	431	325	42.98		Current Meter
27	2486	74	75	* 1	1.35	275.53		756	128	628	83.07		Current Meter
3	2486	74	74	0	0.0	275.53		756	157	599	79.23		Current Meter

Note: 6" Hy. Gate on Tildens entrance opened 2 inch.
Loss of pressure 12 lbs

Sr. No.	Me
1	Em
2	Cr
3	He
4	Cre
5	Tor
6	Ge

TABLE SHOWING PER CENT OF

Sizes	Meters	1/16 inch Opening					1/8 inch Opening					1/4 inch opening					3/8 inch opening					1/2 inch opening					5/8 i
		Condition				Average	Condition				Average	Condition				Average	Condition				Average	Condition				Average	Co
		B	C	D	E		B	C	D	E		B	C	D	E		B	C	D	E		B	C	D	E		B
3/4"	Empire																										
1"	Crown	4.8		12.37	13.86	10.34	2.6		2.08	0.50	1.73	0.0		0.07	0.0	0.2	0.0		0.0	0.0	0.0	0.18		0.0	0.15	0.11	0.5
3"	Hersey	4.8		6.18	7.92	6.30	1.3		1.56	*0.25	0.87	0.43		0.0	*0.14	0.09	*0.34		*0.74	*0.55	*0.54	*0.13		*0.4	0.08	*0.15	0.1
6"	Crest	96.4		91.75	93.06	93.73	58.3		31.25	65.73	55.09	16.3		17.56	18.80	17.55	7.12		11.20	5.11	7.81	5.95		5.73	5.27	5.65	5.6
6"	Torrent	100.		100.	100.	100.	98.4		99.47	100.	99.29	25.68		99.72	100	75.13	7.08		99.06	97.97	68.03	4.89		11.59	100.	38.82	3.3
6"	Gem	100.		100.	100.	100.	96.9		96.87	98.47	97.41	96.9		99.16	98.58	98.21	44.15		62.32	54.04	53.50	28.41		26.63	26.0	27.01	18.9

*over-registration

Discharge
1/16 in. Stream
1/8 " "
1/4 " "
3/8 " "
1/2 " "
5/8 " "
3/4 " "
1 " "
1 " "
1 1/2 " "
2 " "
Ordinary Use

Note: Ordinary use, the intermittent use of water for two sinks, two water closets, one washstand and testing tank.

CENT OF UNRECORDED FIOW OF DIFFERENT WAT

ch opening				½ inch opening					¾ inch opening					1 inch opening					1 inch opening					1½ inch Opening				
dition			Average	Condition				Average	Condition				Average	Condition				Average	Condition				Average	Condition				Average
C	D	E		B	C	D	E		B	C	D	E		B	C	D	E		B	C	D	E		B	C	D	E	
	0.0	0.15	0.11	0.54		0.40	0.46	0.46	0.66		0.6	0.53	0.59	0.58		0.96	0.31	0.61										
	*0.4	0.08	*0.15	0.17		*0.08	0.15	0.08	0.40		0.0	0.21	0.20	0.06		0.32	0.31	0.23		2.91	2.29	3.94	3.04		32.43	37.01	31.94	33.79
	5.73	5.27	5.65	5.60		5.39	5.05	5.34	5.33		5.04	4.92	5.09	5.21		5.14	4.61	4.98		2.91	2.29	6.58	3.92		8.78	11.69	6.94	9.13
	11.59	100.	38.82	3.31		8.76	100.	37.35	2.80		7.18	100.	36.66	2.34		6.43	100.	36.25		*1.94	1.14	0.0	*0.26		*3.37	0.0	2.77	*0.20
	26.63	26.0	27.01	18.26		17.13	19.29	18.46	17.20		14.37	14.75	15.44	16.16		13.15	12.53	14.28		0.0	1.14	2.63	1.25		0.67	6.5	1.39	1.92

SUMMARY

ischarge	First	Second	Third	Fourth	Fifth
in stream	Hersey	Crown	Crest	Torrent	Gem
" "	Hersey	Crown	Crest	Gem	Torrent
" "	Hersey	Crown	Crest	Torrent	Gem
" "	Crown	Hersey	Crest	Gem	Torrent
" "	Crown	Hersey	Crest	Gem	Torrent
" "	Hersey	Crown	Crest	Gem	Torrent
" "	Hersey	Crown	Crest	Gem	Torrent
" "	Hersey	Crown	Crest	Gem	Torrent
" "	Torrent	Gem	Hersey	Crest	
" "	Torrent	Gem	Crest		
" "	Gem	Torrent	Crest		
dinary Use	Crown	Hersey	Crest	Torrent	Gem

WATER METERS.

opening tion			2 inch opening condition					Ordinary Use condition					General Average of unrecorded flow	Competitive position
D	E	Average	B	C	D	E	Average	A	B	D	E	Average		
								0.0	0.0 0.0	0.63	0.0	0.12	1.57%	Second
.01	31.94	33.79			38.35	36.48	37.41	0.6	0.0 0.1	0.12	0.79	0.33	1.12 % 6.80% gate partially open	First
59	6.94	9.13			4.10	4.05	4.08	96.61	17.74 17.96	33.63	42.98	45.78	21.51 %	Third
.0	2.77	0.20			4.10	1.35	1.38	6.50	21.36 81.17	85.37	89.07	56.01	45.70 % The stoppage of this meter, therefore, increased the average.	Fifth
.5	1.39	1.92			1.37	0.0	0.68	11.66	19.76 95.93	86.07	79.29	64.70	41.07 %	Fourth

TABLE SHOWING PER C

Meters.	Condition					Condition				
	B	C	D	E		B	C	D	E	
Empire										
Clown	4.8		12.37½	10.34	2.6		2.06	0.85		
Hersey	4.8		6.18	7.32	6.30	1.3		1.76	0.25	
Crest	96.4		91.75	82.06	82.73	62.3		91.25	62.3	
Torrent	100.		100.	100.	100.	96.4		93.47	100.	
Gem	100.		100.	100.	100.	96.9		96.87	96.87	

*Over-irrigation

Note: Ordinary use
use of water for two
close to one hour

the meter manufacturers to a more thorough consideration of the requirements of both water departments and insurance underwriters."

To successfully establish a large meter-testing plant, the necessary requisites are, first, an abundant water supply; second, readiness for rapid drainage; third, suitable apparatus.

On the department's premises at Lowell we found two places combining the first two requisites; the first location considered was at Station 2, where the apparatus could be erected in the open, similar to the one installed by Mr. Kimball at Knoxville, Tenn., which gave such excellent results. At Lowell this arrangement would have the disadvantage of being serviceable during the warm weather only, and another objection was that this station is a reserve plant and consequently the apparatus would have to be housed after each series of tests; and further, notwithstanding that water is cheap to the department, if a willful waste can be avoided it is in line of economy. The second place, and the one selected, was in the engine-room of Station 1, it having, in our opinion, all the requisites, with the additional advantages of being ready for use at any or all times, economy of water, compactness, light, heat, pleasant and convenient surroundings, and proximity to water-works repair shop. The engine-room being large and roomy, we selected the westerly side and installed what is probably the first permanent testing plant, of its kind, for large meters.

This station is located about one-half mile from the low-service reservoir, with a capacity of 30 000 000 gallons, supplying the city proper through a 30-inch delivery pipe; branching from this pipe, near the reservoir, a 12-inch distribution-pipe line runs directly down hill and into the basement of the pumping-station, there being reduced to an 8-inch pipe, supplying the high-service pump; an 8-inch branch was cut into this line and the pipe laid under the basement floor to the westerly wall of the station; an 8-inch elbow with riser extended to 25 inches above engine-room floor; another 8-inch elbow reducing to 6-inch pipe with a 6-inch gate valve controlling the inlet; from this valve about 8 feet of 6-inch wrought-iron pipe to inlet piezometer; next a space for the insertion of any size meter or device from 3 inches to 12 inches, the meters being swung into position by means of a hoisting rigging; on the

outlet flange of the meter another piezometer ring was attached, then about 8 feet more of wrought-iron pipe to pressure piezometer and nozzles; between the nozzles and meter a 6-inch valve was sometimes inserted to keep the apparatus from draining and at the same time obtain conditions similar to what is often found in actual use; the nozzles discharged through a sheet-iron spatter box, seven and one-half feet long, into and against a 24-inch cast-iron deflector elbow set directly over the pump well; this deflector complies with the second requisite for testing, readiness for rapid drainage, without discharging or wasting into the open. See Plates VIII and XI.

The whole apparatus is held up in position with adjustable braced wooden chairs, with iron clamps holding the pipes firmly in position without undue vibration. Under the whole string of pipe and apparatus is placed a drainer pan to catch the condensation, drippings or bleeding of the line, all of which wastes into a sewer drain.

To obtain nozzle discharges, the methods used were substantially those given by Mr. John R. Freeman in his paper on "Hydraulics of Fire Streams," published in Vol. XXI of "Transactions of the American Society of Civil Engineers," and those in his paper on "The Nozzle as an Accurate Water Meter," in "Transactions of the American Society of Civil Engineers," Vol. XXIV, and from methods described by Mr. Frank C. Kimball in his paper before this Association, September, 1903, entitled, "Some Six-Inch Meter Tests and How They were Made." *

The nozzles used ranged in size of orifice from ⅛ inch to 4 inches and were made by the Hersey Manufacturing Company, and constructed in accordance with the requirements from experiments by Mr. Freeman.

The tests for small flows, that is, 1–16-inch, ⅛-inch and ¼-inch streams, were determined by attaching a 2-inch gate valve on end of 2-inch nozzle and screwing on outlet side a brass cap with circular brass disk, having a "standard circular orifice with sharp edges"; the coefficients for these discharges were determined by experiment.

The water pressure was measured by means of an open mercury column with graduated scale reading to a tenth of a pound. The

* JOURNAL, N. E. W. W. Ass'n., December, 1903, Vol. 17, p. 305.

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The nozzles used ranged in size of orifice from $\frac{1}{8}$ inch to 4 inches and were made by the Hersey Manufacturing Company, and constructed in accordance with the requirements from experiments by Mr. Freeman.

The tests for small flows, that is, 1–16-inch, $\frac{1}{8}$-inch and $\frac{1}{4}$-inch streams, were determined by attaching a 2-inch gate valve on end of 2-inch nozzle and screwing on outlet side a brass cap with circular brass disk, having a "standard circular orifice with sharp edges"; the coefficients for these discharges were determined by experiment.

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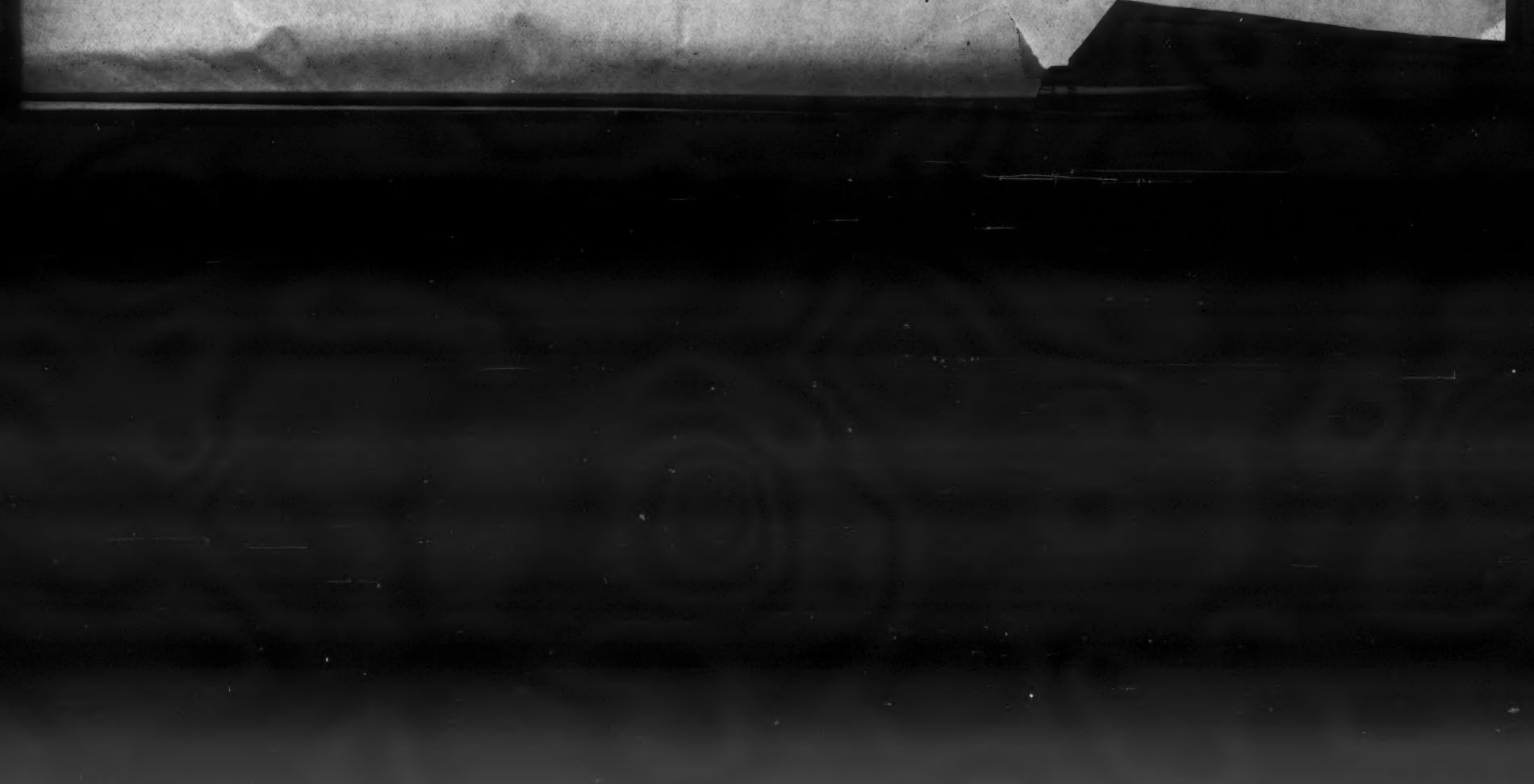
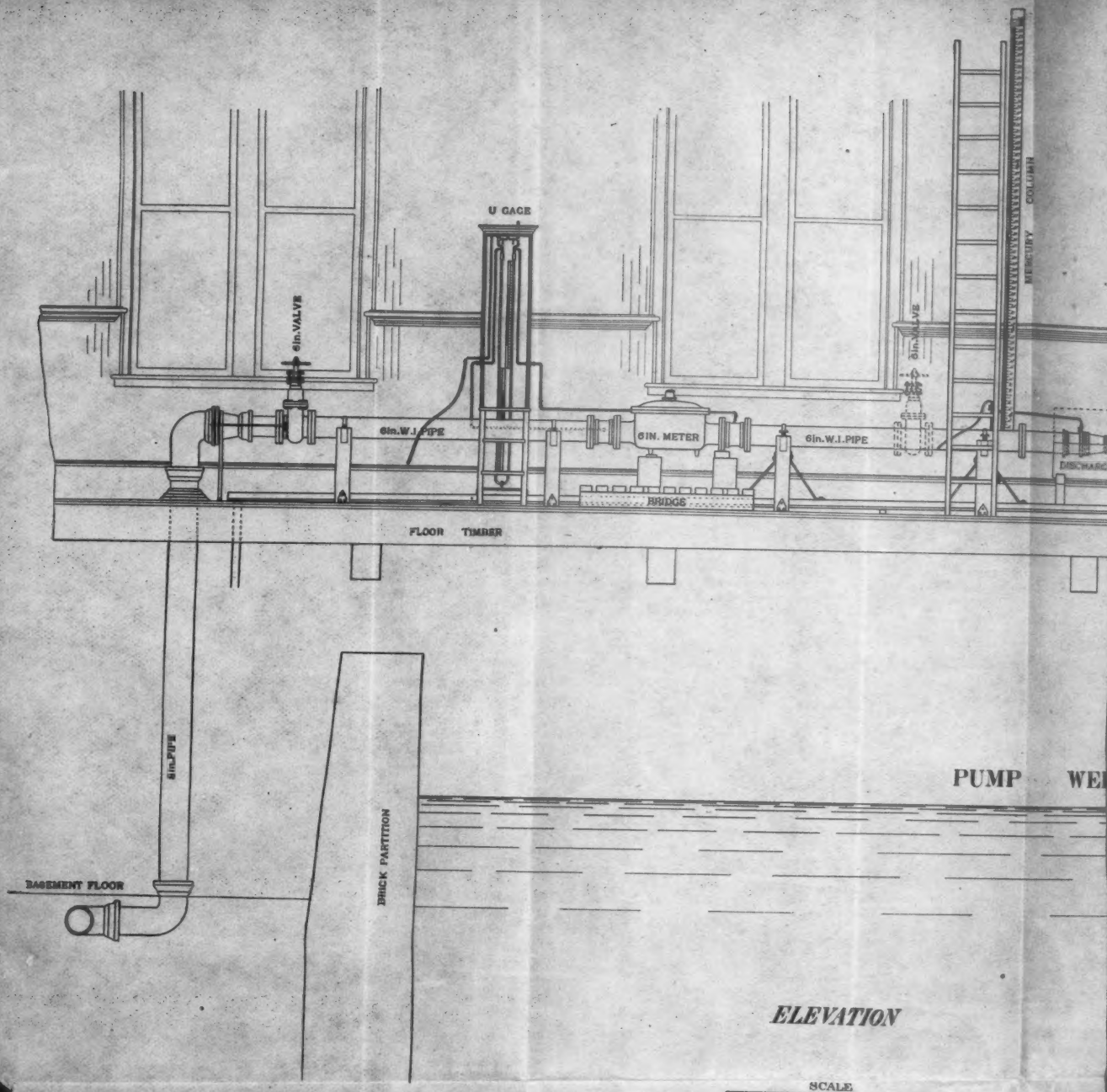
* JOURNAL, N. E. W. W. Ass'n., December, 1903, Vol. 17, p. 305.

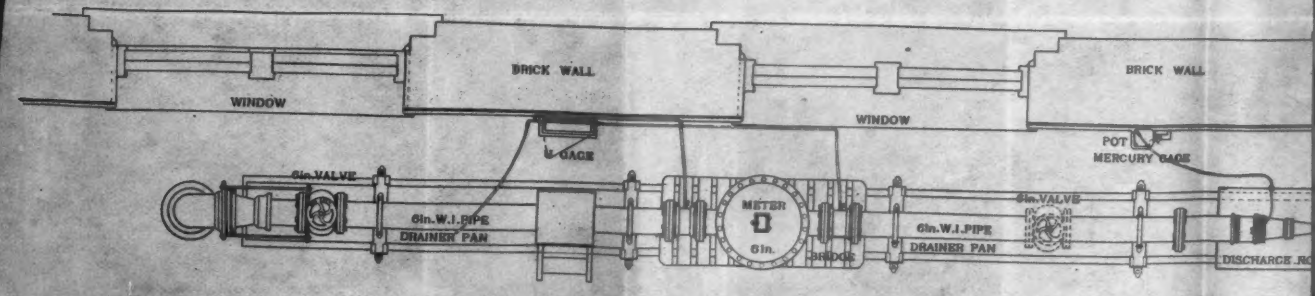




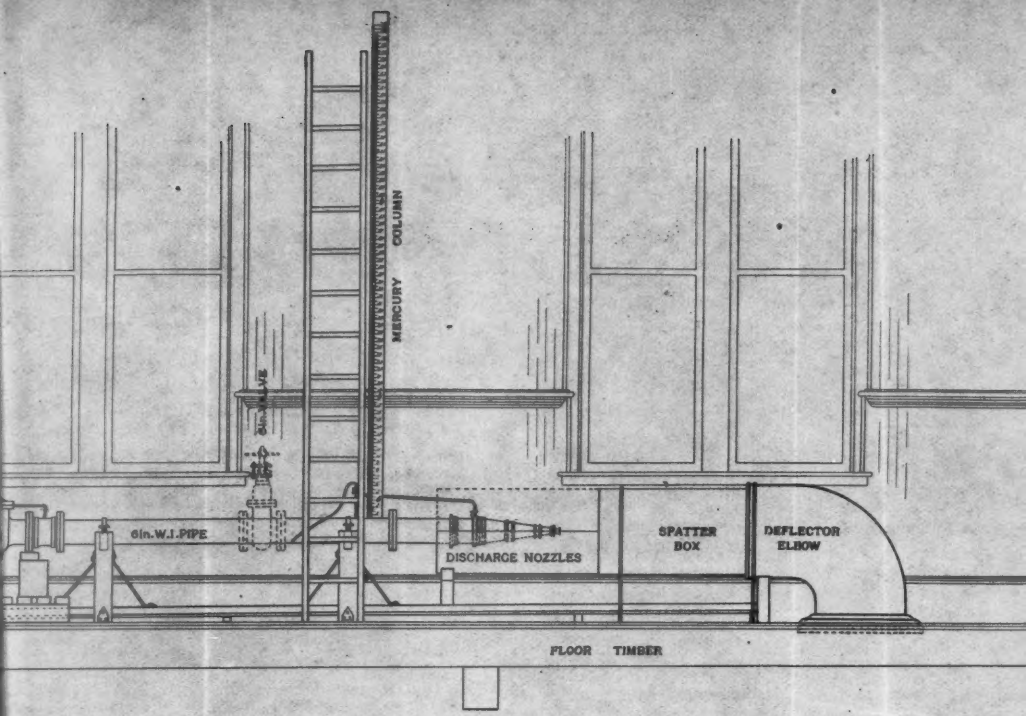
ELEVATION

SCALE

0 1 2 3 4 5 6 FT.



PLAN



PUMP WELL

ELEVATION

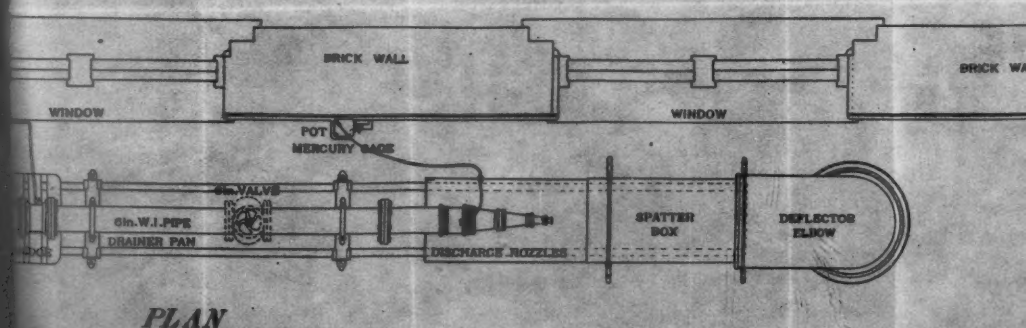
Plan Showing Apparatus for Testing Large Meters and Fire Service Devices at Lowell Water Works Lowell Mass.

Feb. 1905

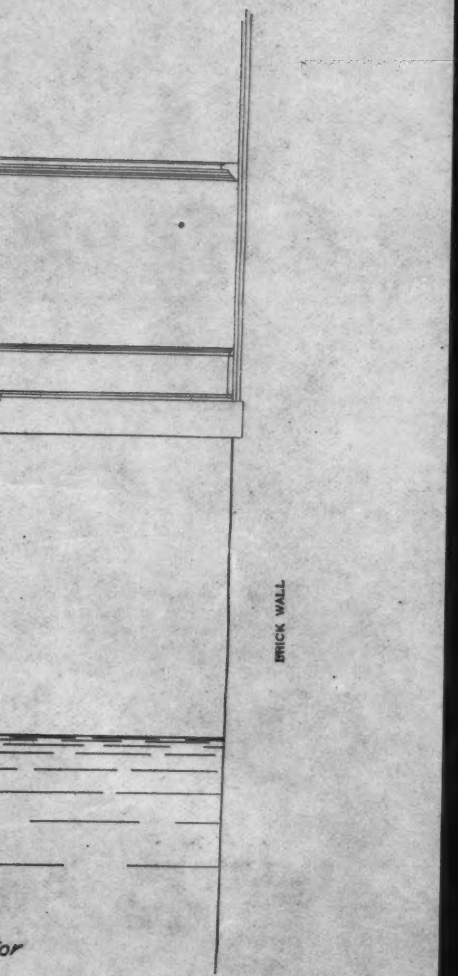
W.F. Sullivan Eng.

SCALE

0 1 2 3 4 5 6 FT.

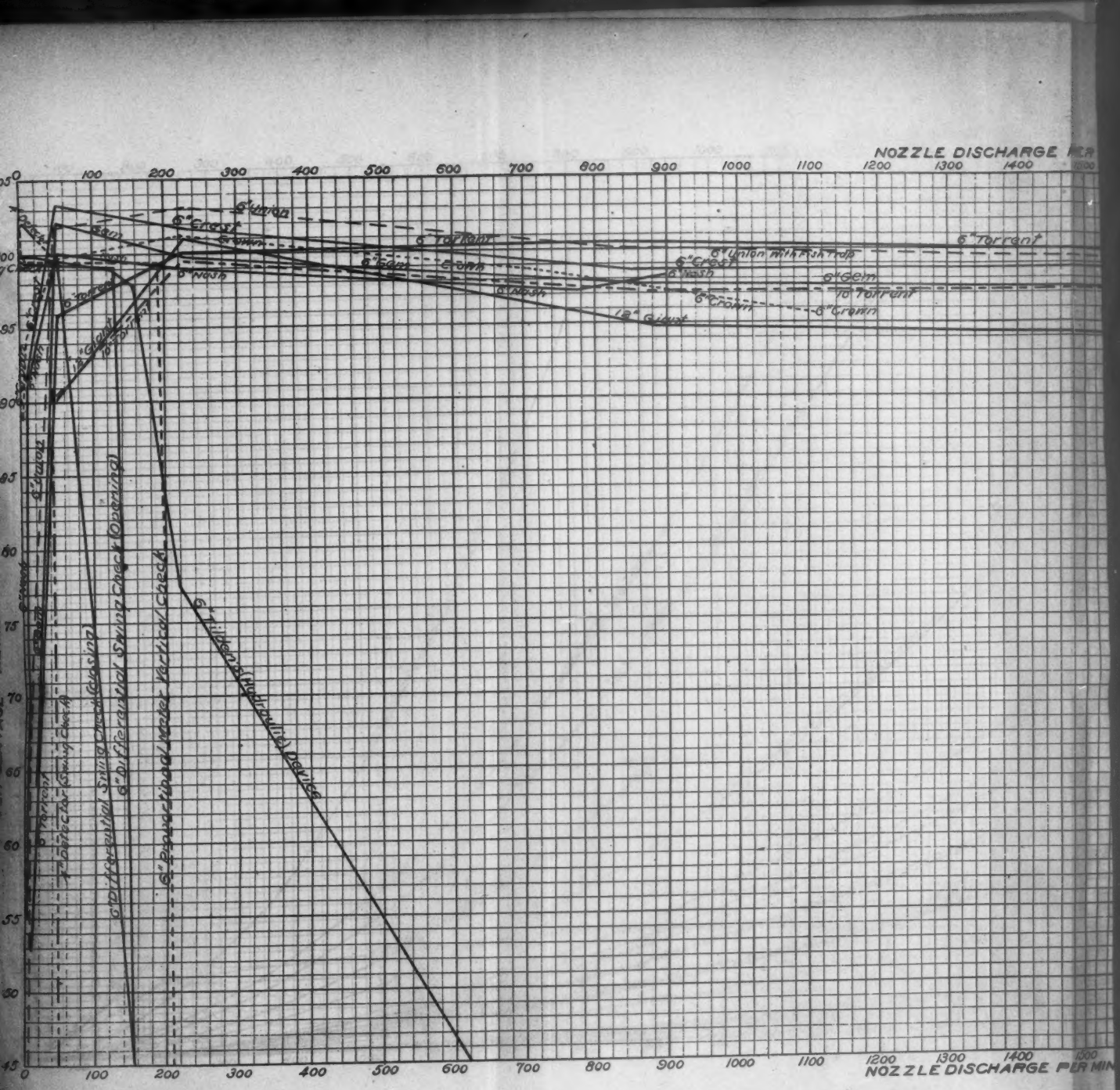


PLAN


BRICK WALL

BRICK WALL

PER CENTAGE METER REGISTRATION
Portion
Detector Swing Chart A


NOZZLE DISCHARGE PER
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
6" Torrent
6" Union
6" Crosst
6" Torrent
6" Union with Fish Traps
6" Crosst
6" Wash
6" Torrent
6" Crown
6" Wash
6" Crown
6" Crown
12" Gibst
6" Torrent
6" Crosst
6" Wash
6" Crown
6" Gem
to Torrent
6" Crown
6" Torrent
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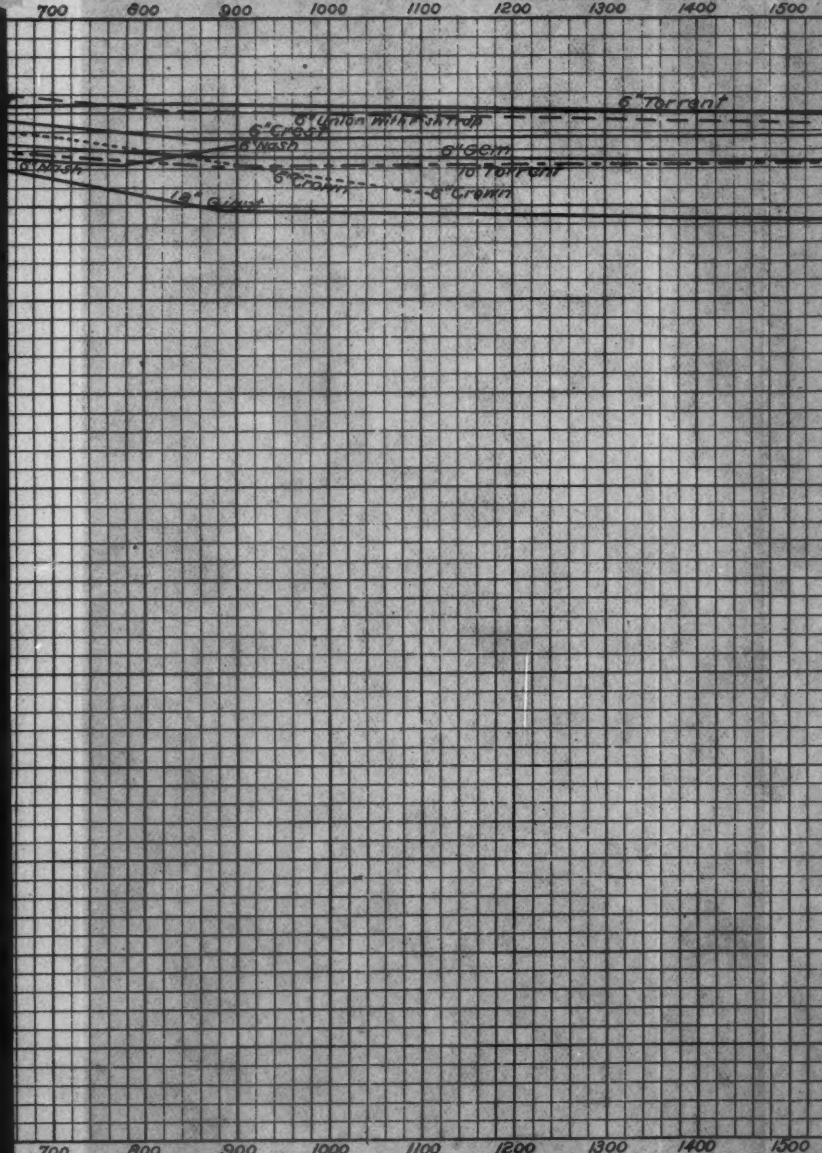
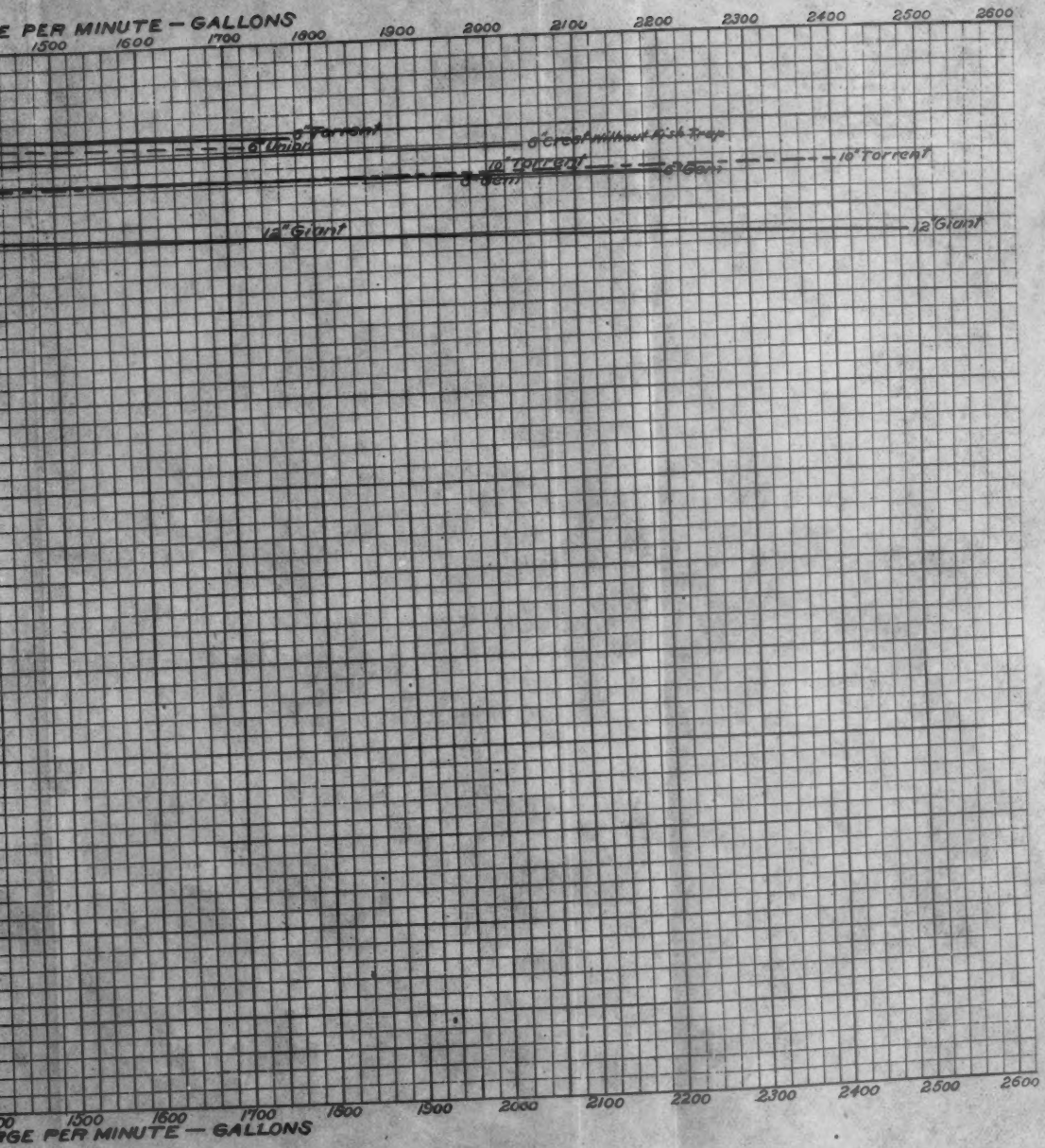
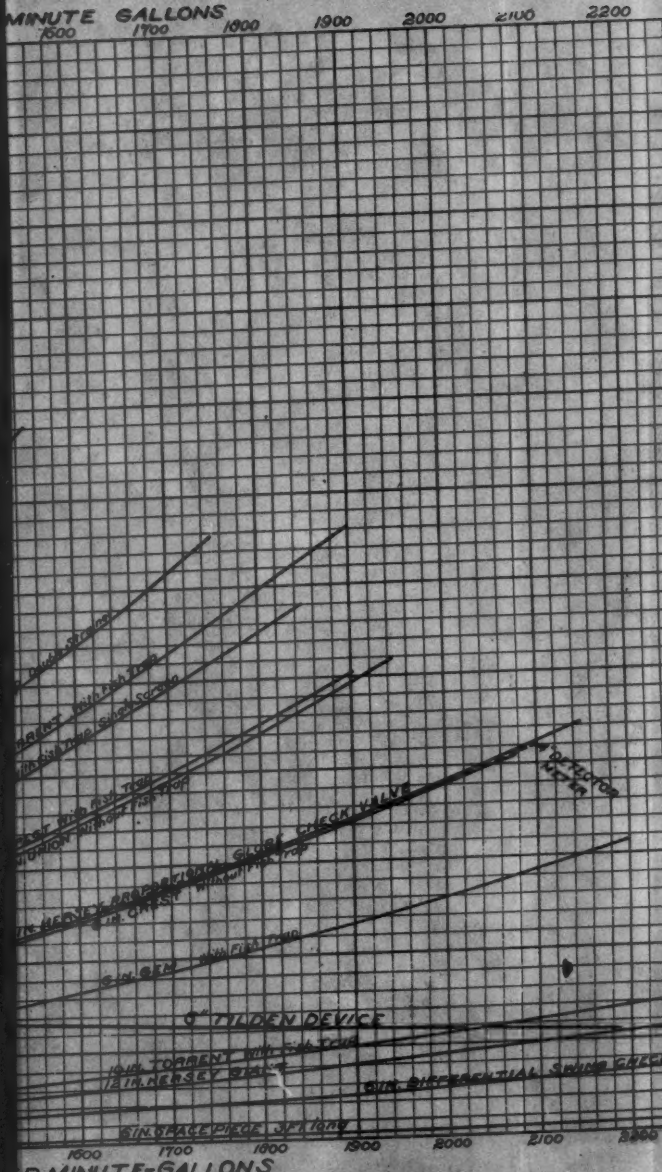
6" Torrent
6" Crosst
6" Wash

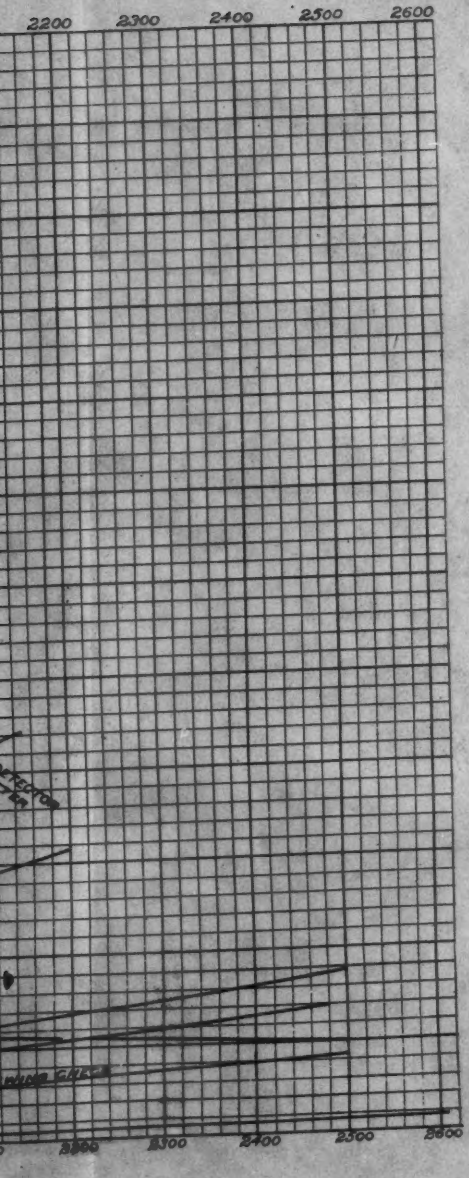

NOZZLE DISCHARGE PER
700
800
900
1000
1100
1200
1300
1400
1500
6" Torrent
6" Union Hi-Ranger
6" Croft
6" Waterous
6" Gem
6" Torrent
6" Croft
6" Croft
12" Gibson
700
800
900
1000
1100
1200
1300
1400
1500
NOZZLE DISCHARGE PER M

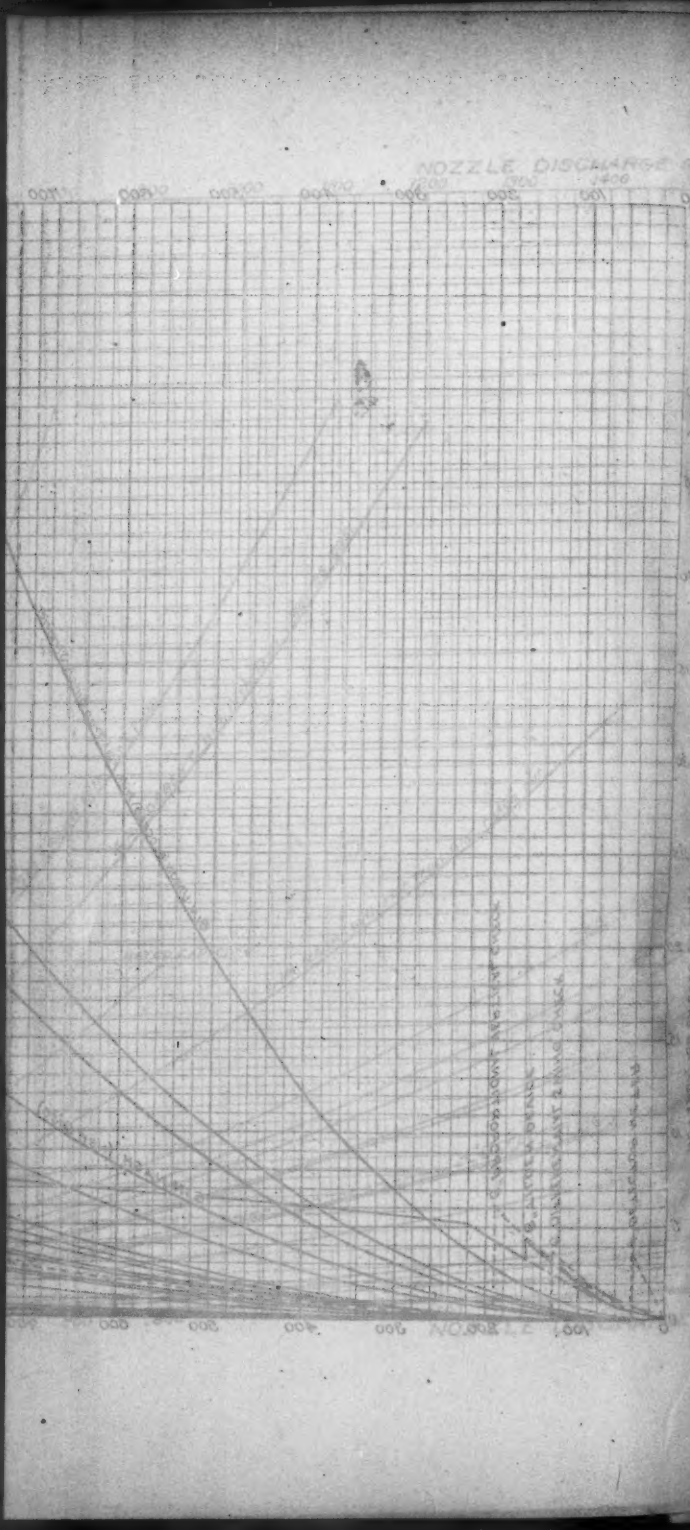

E PER MINUTE — GALLONS
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
6" Torrent
6" Ubiko
6" Crossfire without fish tray
10" Torrent
6" Gem
6" Gem
10" Torrent
12" Giant
12" Giant
GE PER MINUTE — GALLONS

100
60
55
50
45
40
35
30
25
20
15
10
5
0
100

NOZZLE DISCHARGE PER MINUTE
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
RATED CAPACITY
6 IN. NASH (FROM 1937)
4" DETECTOR METER
NOZZLE DISCHARGE PER MINUTE-


MINUTE GALLONS
1600
1700
1800
1900
2000
2100
2200
6" TILDEN DEVICE
10" TORRENT
12" JERSEY
SINGLE PACE PIPE
1600
1700
1800
1900
2000
2100
R MINUTE-GALLONS


2200
2300
2400
2500
2600
2300
2400
2500
2600



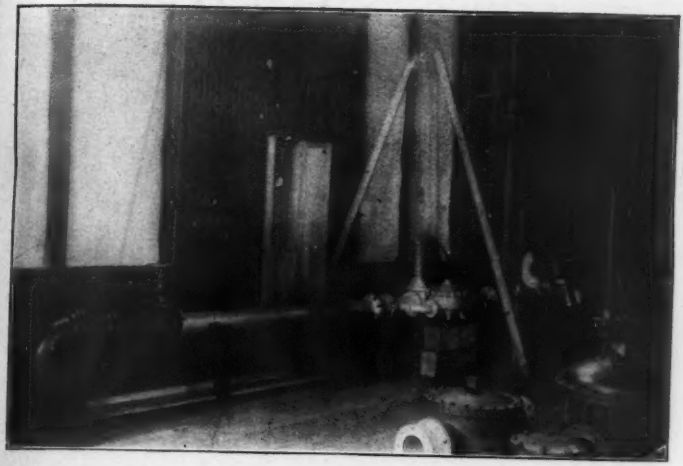


FIG. 1. TESTING APPARATUS.

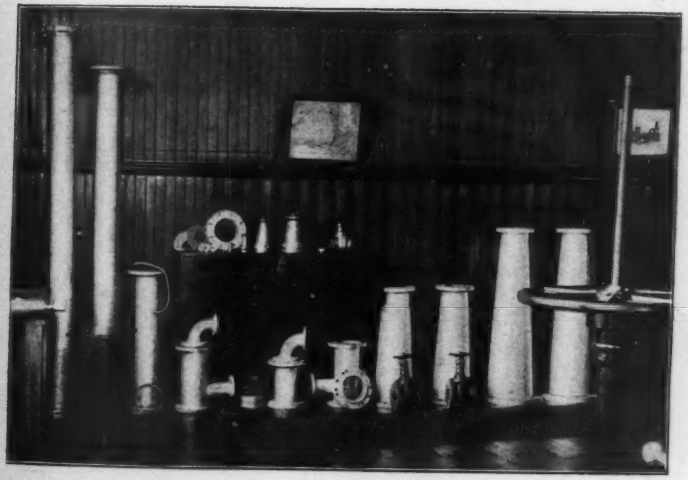


FIG. 2. GROUP OF ADAPTERS.

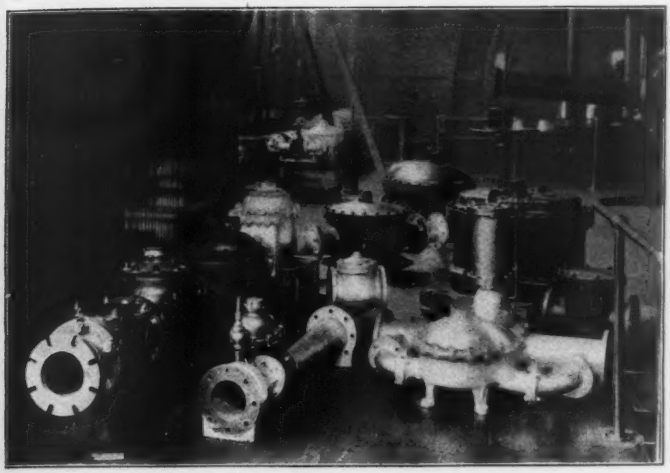


FIG. 1. GROUP OF METERS TO BE TESTED.

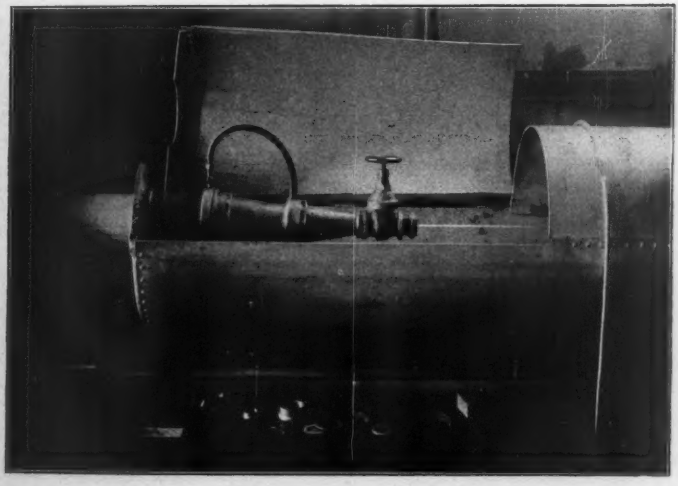


FIG. 2. ¼-INCH ORIFICE DISCHARGING 9.64 GALLONS PER MINUTE.

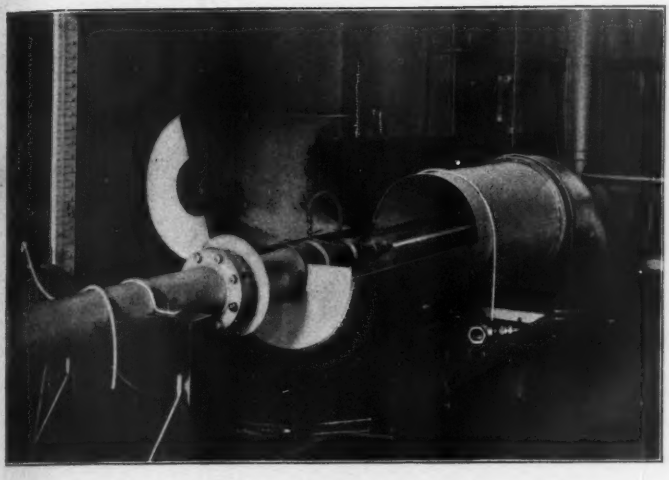


FIG. 1. ½-INCH NOZZLE DISCHARGING 56.8 GALLONS PER MINUTE.

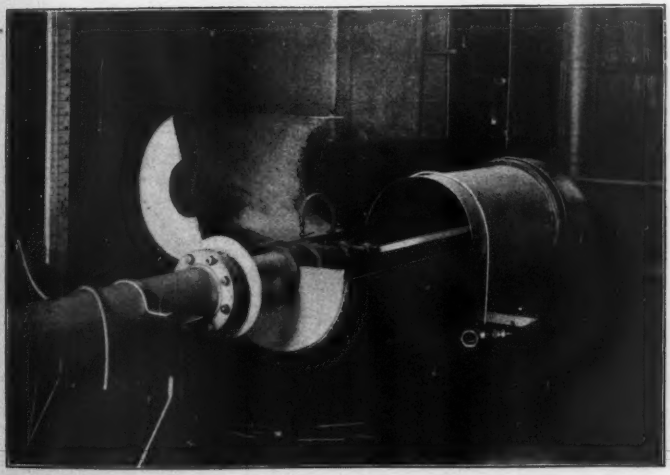


FIG. 2. 1-INCH NOZZLE DISCHARGING 227 GALLONS PER MINUTE.

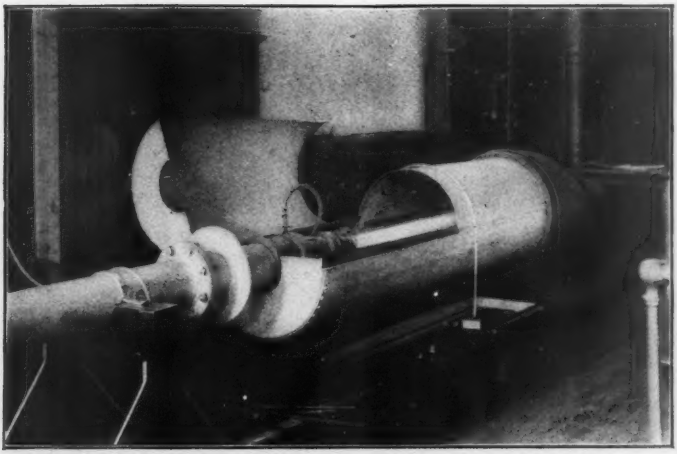


FIG. 1. 2-INCH NOZZLE DISCHARGING 893 GALLONS PER MINUTE.

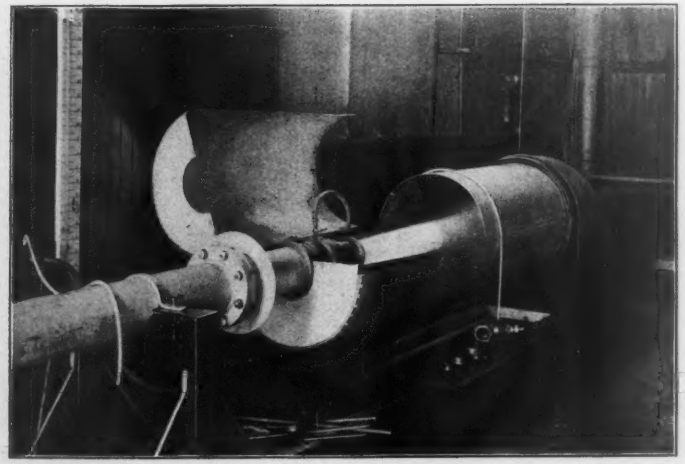


FIG. 2. 4-INCH NOZZLE DISCHARGING 2612 GALLONS PER MINUTE.

PLATE XV.

HERSEY DETECTOR METER.

mercury pot was one of the regular pattern, having a small glass window in the side permitting a comparison of the zero point of scale with mercury in the pot.

For measuring the retardation or loss of pressure in the meters, a mercury U-gage, placed in a cabinet and fastened to the wall, was used. The arrangement of the testing apparatus is shown in plan and elevation on Plate VIII.

To facilitate the work of testing, a complete collection of adapters was procured, including different lengths of 6-inch pipe and nipples, flanges with standard drilling, reducers, expanders, valves, etc. By the use of these adapters any machine from 3 inches to 12 inches can, in a short time, be inserted in the apparatus ready for testing. (Plate XI, Fig. 2.)

The following is a list of adapters employed:

2 pieces 6-inch wrought-iron pipe, 8 feet long.
1 piece " " " 7½ " "
1 " " " " 7 " "
1 " " " " 6 " "
1 " " " " 4 " "
1 " " " " 3 " "
1 " " " " 2 " "
2 pieces " " " 1 foot "
2 " " " " short nipples.
2 6-inch x 3-inch flanged reducers.
2 6-inch x 4-inch " "
2 6-inch x 8-inch " expanders.
2 6-inch x 10-inch " "
2 6-inch x 12-inch " "
2 4-inch flanged elbows.
2 6-inch " "
2 6-inch gate valves.
2 3-inch " "
1 2-inch gate valve.
6 pairs drilled flanges.

The elevation of center of nozzles was 39.6 feet above city datum; the level of high water in the reservoir is 181.5 feet, thus giving a static head of 141.9 feet, or a pressure of about 61.4 pounds. Notwithstanding that the 12-inch pipe from the reservoir fed several laterals of the supply system, the pressures given by the mercury column were reasonably free from fluctuations.

In compiling data we were enabled to obtain easily and graphically, for purposes of comparison during each series of tests, the retardation by plotting the indicated loss of pressure on square root or second-power paper from plate made by Mr. J. A. Tilden, of the Hersey Manufacturing Company.

In finding the relation or difference between the meters and devices tested and straight plain pipe, the space usually occupied by the meter in the apparatus was fitted with a 3-foot "filling-in piece" of 6-inch pipe. Under this condition the quantity of water discharged and loss of head were obtained by the use of different sized nozzles, thus showing the available delivery and loss of pressure or friction in the apparatus, as follows:

TABLE No. 1.

Size of Nozzle or Opening.	Gallons discharged per Minute.	Loss of Pressure in Pounds.
4-inch	2 612	0.8
2 "	893	0.1
1 "	227	0.0
½ "	56.8	0.0
¼ "	9.64	0.0
⅛ "	2.60	0.0
1/16 "	0.55	0.0

With tests under similar conditions, the above table permits a comparison of flows and loss of pressure between the meters and devices tested and the maximum discharge and minimum loss of pressure. The only correction necessary, and that is inappreciable, is for the difference in static head due to the slightly varying level of water in the reservoir.

The following brief description and summary of the meters tested may be of assistance in recognizing the functions of different types of meters and devices.

Six-Inch Crown Meter, with fish trap, manufactured by the National Meter Company. "The Crown is a rotary piston positive displacement meter"; the smaller sizes, in many places, are recognized as a standard for accuracy and durability. The maximum capacity of this meter under local conditions through a

4-inch nozzle was 1 109 gallons per minute, with a loss of pressure of about 49 pounds; the sensitiveness on ⅛-inch and ¼-inch streams was 91.5 per cent.; on flows from 56 to 1 109 gallons, its accuracy was 98.75 per cent.

Six-Inch Nash Meter, special pattern with fish trap, made by the National Meter Company. The Nash is of the disk type, commonly called a positive meter. The disk is made of hard rubber, reinforced and strengthened with metal. While flushing the meter, preliminary to the test, and discharging about 1 100 gallons per minute, or 22 per cent. more than its rated capacity, the disk broke into six pieces, twisting and bending the metal reinforcement. The rated capacity of the meter is 900 gallons. With the broken disk the meter discharged 840 gallons, or only 6.6 per cent. less than the rated capacity. After removing the broken disk it was found that the capacity of the case was 1 540 gallons, with a loss of pressure of 39 pounds.

The broken disk was replaced by a new one and the discharge limited to the rated capacity, 900 gallons. With this flow the loss of pressure was 18.65 pounds. For accuracy on flows of 56 gallons and over, this meter registered about 99 per cent.; on discharges of 10 gallons, about 91 per cent., and 2½ gallons, 55 per cent.

Six-Inch Union Rotary Piston Meter, manufactured by Union Water Meter Company, of Worcester. This meter is of the positive type, and has been well and favorably known by water-works people for over twenty-five years. "The meter is constructed of composition and consists of two pistons rotating in contact with each other upon vertical axes within a cylindrical chamber," each piston in turn being impelled by the elliptical gearing. This meter with double screened fish trap delivered 1 725 gallons per minute, with a loss of pressure of about 33 pounds. Removing the screens, the delivery was 1 930 gallons, with a loss of 25.75 pounds. Testing this meter again, by replacing the coarse strainer with an increased number of ¼-inch holes, we found that it was capable of passing 1 840 gallons per minute, with a loss of 28.6 pounds. This meter is large and bulky, its parts are solid and substantially made, yet a remarkable feature of this weighty machine is its ability to record 57.7 per cent. of the flow on ¼-inch streams, while on streams above ¼-inch the registration was about 100 per cent.

This meter was blocked by placing a small wedge between one of the pistons and the body of meter; the pistons in this position allowed 825 gallons to slip or pass through the meter, with an estimated loss of pressure of over 50 pounds.

Six-Inch Hersey Torrent Meter, with fish trap, manufactured by the Hersey Manufacturing Company, is of the current type. The piston is a balanced horizontal wheel, revolving on a vertical spindle by impact from the water which is directed against it by the deflector vanes. The revolutions are governed by the quantity of water passing, and communicate to a dial which indicates the measurements. On flows under 50 gallons per minute the registration is variable; between ½-inch and 4-inch streams the average registration is 99 per cent. The maximum capacity of this meter was 1 830 gallons per minute, with a pressure loss of 31 pounds.

The exterior appearance of this meter is small and compact, yet the interior is capacious; its working parts are simple and it can easily be regarded as a serviceable model of the current meter.

Six-Inch Crest Meter, manufactured by the Neptune Meter Company. This meter is of the current or velocity type. The makers claim a "more effective adaptation" of the helix or screw. To give greater or less sensitiveness, depending upon the relative degree of sensibility required, the propeller spaces can be made less or more. After some experiments under local conditions, including changes and adjustments of the working parts, this current meter made the remarkable record of registering 89 per cent. on a flow of 9½ gallons per minute, while the registration on the higher flows ranged from 92 to 103 per cent. The action of this meter, with fish trap, during some of the tests was slightly erratic. Without fish trap, this meter passed 2 070 gallons per minute with a pressure loss of 21.7 pounds; with fish trap, it delivered 1 905 gallons with a loss of 25.4 pounds.

Six-Inch Gem Meter, with fish trap, made and presented for testing by the National Meter Company. This meter is of the current propeller type, similar to many of the same kind now in use throughout the country. This meter was capable of delivering more water than any other 6-inch current meter tested, and with less loss of pressure; that is, 2 200 gallons per minute, with a loss of 15.9 pounds. It registered on flows above 50 gallons

99.12 per cent.; below 30 gallons the registration was neither constant nor substantially correct.

Ten-Inch Hersey Torrent, with fish trap, is a larger model of the 6-inch Torrent before mentioned. This meter delivers 2 410 gallons per minute with a net loss of 8 pounds; the accuracy on flows from 56 to 2 410 gallons was 96.1 per cent.

Twelve-Inch Giant Meter, manufactured and presented for testing by the Hersey Manufacturing Company. The design consists of a converging tube on inlet side and a diverging tube on outlet side, the two joined together with a throat piece having an annular core with openings into the tube. On top is placed a by-pass meter, so proportioned that one twentieth of the water passes through the meter and the other nineteen twentieths through the tube; the inlet to the by-pass meter was from the converging tube; and the outlet into the throat piece. During the first series of tests this meter registered on streams larger than ½ inch 94.8 per cent. The gearing was then changed and another series of tests made; the registration then showed about 104 per cent. The capacity of this meter was 2 490 gallons, with a net loss of 7.25 pounds.

Six-Inch Tilden Device, manufactured by the Hersey Manufacturing Company, and described in "Report of Committee on Private Fire Protection" to the New England Water Works Association, February, 1904, as follows:* "In the device submitted a 3-inch meter is set in a by-pass around a double-faced gate valve with parallel seats, the face toward the pressure being bored to admit of the passage of water through the same, and thence up around the stem into a cylindrical chamber directly above the valve, through the center of which the valve stem extends.

"In the cylindrical chamber, attached to the valve stem, is a cup-leather plunger, placed cup down or against the pressure, and weighted to such extent as with the weight of the valve and stem to constitute a force, tending to keep the valve closed, equal to the pressure per square inch which it is designed to absorb in the apparatus."

"The cup-leather packed valve-operating plunger is, as regards the pressure from the lower or inlet side, absolutely tight. The

* JOURNAL, N. E. W. W. Ass'n, June, 1904, Vol. 18, p. 198.

valve itself is, as usual, a single-faced gate closed by the pressure. The pressure at the inlet, conveyed through the hole in the valve and up around the stem to the under side of the valve-opening plunger, is balanced by the pressure on the outlet side of the valve, the same being conveyed to the top of the plunger through a brass tube."

This device was designed to record accurately small flows, and yet be capable in the event of fire of delivering almost as much water as straight plain pipe. This device demonstrated its ability to discharge within 4½ per cent. of the available supply. With a static head of 61.4 pounds, it furnished 2 500 gallons per minute, with a loss of only 4.95 pounds. It further substantiated the claim made for it by recording 100 per cent. of the flow of all streams up to 157 gallons per minute, the opening point of the hydraulic gate valve; the loss of head at the opening point was 4.25 pounds.

The registration on flows from 157 to 2 500 gallons per minute ranged from 98 to 5.8 per cent. and the retardation from 7.9 to 4.95 pounds.

This device has been repeatedly set up and tested for exhibition purposes; on each and every occasion it has been positive in its action, and has not shown any tendency to stick, either while in actual operation or by the opening and closing of the small valve on the connection to the upper side of plunger.

Six-Inch Proportional Vertical Check Valve (experimental), submitted by the Hersey Manufacturing Company and designed by Mr. J. A. Tilden. As far as the registration on small flows is concerned, the province of this device is similar to the Tilden device just described, the only change being the elimination of what might be called the open-and-shut gate valve. This device consists of a 3-inch Hersey disk meter set in a by-pass around a vertical check valve placed in a horizontal line of 6-inch pipe. The principle of the valve is that a loss of 10 per cent. of the pressure on the outlet side opens the check and allows the water to flow through the run of 6-inch pipe in addition to what is passing through the by-pass meter. These results are obtained in the following manner: A brass check fits on a ring seat, also on a 2-inch tube which has an outlet to the atmosphere through a

telltale meter; a guided spindle extends above and below the seat insuring a reseating of the check. The difference in area of upper and lower surfaces of the check is over 10 per cent. In practice, this check remained closed until the difference in pressure was 6.3 pounds, or, in other words, until the by-pass meter delivered 191 gallons per minute, when the check opened and the frictional loss dropped to 0.2 of a pound.

The accuracy of the by-pass meter on flows from ½ gallon to 191 gallons per minute was 101.6 per cent. This device delivered 2 065 gallons per minute with a pressure loss of 20.65 pounds. These results are reasonable, considering the narrow and tortuous water passages. The telltale meter serves as an indicator, and while the check is open from any cause discharges water.

Six-Inch Differential Swing-Check Device (experimental), designed by Mr. J. A. Tilden, of the Hersey Manufacturing Company. The purpose of this device is to accurately record small flows and to detect large flows by means of the telltale meter attachment, even to the extent of approximating the water used during a fire, also to reduce the loss of pressure when large quantities of water are needed, so that the retardation will be unimportant in case of an emergency. In principle the arrangement is similar to the proportional vertical check, except that in place of the vertical a swing check is inserted in the pipe line. An annulus or groove opening to the atmosphere, to which may be attached the telltale meter, is cut into the inclined brass seat in place of the two-inch tube in the vertical check.

The inlet and outlet areas of the swing gate exposed to the pressures are so proportioned that when there is a loss of 3.3 pounds on the outlet side, or, to express it in another way, when 128½ gallons per minute flow through the by-pass meter, the swing check opens and the frictional loss is reduced to about 0.2 of a pound. With a loss of scarcely 4¼ pounds, this device delivered 2 495 gallons per minute.

During the first series of tests this device operated satisfactorily, while in the second series the telltale, with no water discharging from the nozzle, indicated that either the check did not cover the annulus or else the check did not completely close. An inspection showed only a very slight wear of the rubber face of the check.

If this condition should arise in actual practice it would be difficult to determine whether it was a leakage into the annulus, or, where the fire-service piping system is concealed, how much water was being wasted. This seems to be an inherent defect in this particular swing-check device. With this device there is no pointer or indicator to show the degree of opening of the check.

Four-Inch Swing-Check Device (experimental) is a smaller size and similar in construction and purposes to the previously described device. In place of the 6-inch a 4-inch swing check is used, and in place of a 3-inch a 2-inch disk meter is placed on by-pass.

The capacity of this appliance is 2 100 gallons per minute, with a net loss of 21 pounds in pressure.

The by-pass meter registers about 100 per cent. of the flow on streams discharging from ½ gallon to 41 gallons, the opening point of the check. The indicated loss of pressure just as the check is about to open is 3.65 pounds, when simultaneously with the opening the U-gage shows a loss of only 0.3 of a pound. Following the opening of check, and while discharging 41 gallons, the by-pass meter registered 27 per cent.

The check, having opened automatically with a draught of 41 gallons per minute, did not close again until the water was entirely shut off, and then only by quickly closing the valve and giving it a jar or shock, thus showing that during a portion of the experiments the telltale was misleading, in so far as it continued to discharge water when no water was being used at the outlet.

NOTE, August 18, 1905. Since the foregoing tests were made the Hersey Manufacturing Company have presented for testing at Lowell a Hersey Detector Meter. In appearance and arrangement it is similar to the 6-inch experimental differential swing-check device previously described, except that in place of the "stock" checks, with their inherent defects, it has a specially designed check valve, with a weighted flapper consisting of a hollow brass ball inside the case; if desired, the ball can be weighted with shot, thus varying the opening point of the check, and also enabling the check to close more readily when the flow is reduced.

This device, which is shown in Plate XV, is looked upon favorably by many water-works men and insurance underwriters.

The following is a summary of the tests.

SIX-INCH HERSEY DETECTOR METER WITH IMPROVED CHECK VALVE. BRASS BALL NOT WEIGHTED. METER NO. 233,288. JULY 29, 1905.

Size of Nozzle or Opening.	Gallons per Minute by Nozzle.	Per Cent. Registration on By-Pass Meter.	Loss of Pressure, Pounds.	Remarks.
4-inch	2 460	2.9	2.36	Check open.
2 "	857	4.3	0.5	" "
1 "	220	19.9	0.45	" "
1 "	126	100.0	3.5	Opening point of check.
1 "	128	35.5	0.45	Just after opening.
1 "	49	100.0	0.45	Closing point of check.
1 "	47.7	100	0.5	Just after closing.
½ "	56.5	99.6	0.6	.....
¼ "	9.64	99.5	0.0	.....
⅛ "	2.6	99.0	0.0	.....

SIX-INCH HERSEY DETECTOR METER WITH IMPROVED CHECK VALVE. BRASS BALL WEIGHTED WITH 12-LB. OF SHOT. METER NO. 233,288. AUGUST 9, 1905.

Size of Nozzle or Opening.	Gallons per Minute by Nozzle.	Per Cent. Registration on By-Pass Meter.	Loss of Pressure, Pounds.	Remarks.
4-inch	2 460	2.87	2.45	Check open.
2 "	868	5.68	0.8	" "
1 "	221	26.6	0.8	" "
1 "	139.5	100.0	4.11	Opening point of check.
1 "	145	42.8	..	Just after opening.
1 "	63.6	100.0	0.77	Closing point of check.
½ "	56.5	99.6	0.75	.....
¼ "	9.64	99.5	0.0	.....
⅛ "	2.6	99.0	0.0	.....

Table No. 2 shows the sensitiveness and accuracy of the meters in per cent. of recorded flow, also the flow of different size nozzles.

In Table No. 3 is shown the retardation or loss of pressure with different flows, due to the resistance offered by the meter "dependent upon the intricacy and size of its water passages and the friction of its moving parts."

Plate IX is intended to show, by comparison, the relative recorded flows of the large meters and special fire-service devices.

Plate X shows, on profile paper, the loss of pressure or retardation in meters and fire-service devices.

In a synopsis of the tests we find in the three types of meters represented, the positive displacement, the current, and the special devices:

First. That the 6-inch positive meter is adapted for close registration on all appreciable flows up to its capacity; the average capacity of this type being only 54 per cent. of the available supply through a 6-inch pipe, while the loss in pressure over plain pipe is 3 900 per cent., or in the ratio of 39 to 1.

These figures show that placing a positive meter on a single fire service, designed to furnish water for a certain number of fire-extinguishing fixtures, would be a menace to the risk, unless arranged in parallel or in conjunction with other devices.

Second. That the 6-inch current, velocity or inferential meter is better suited to deliver larger quantities with less loss of head than the positive type. The average current meter will deliver 75 per cent. of the available supply with a loss of 3 062 per cent., or in the ratio of 30.62 to 1, in pressure, excelling the positive meter 21 per cent. in efficiency of flow, and 838 per cent. in loss of head.

Yet this type of meter is not capable, like the positive meter, of standing guard over water-department interests, for the reason that it is unreliable on flows under 50 gallons per minute, or, to express it in another way, most current meters cannot be depended upon to record streams as small as 1-16 inch, $\frac{1}{8}$ inch, $\frac{1}{4}$ inch and sometimes $\frac{1}{2}$ inch with any degree of accuracy.

Types	Meters	⅛ inch opening		¼ inch opening		¼ inch opening		¼ inch Nozzle		1 inch Nozzle		2 inch Nozzle		4 inch Nozzle		Remarks
		Gals per Min	Per Cent	Gals per Min.	Per Cent	Gals per Min.	Per Cent	Gals per Min	Per Cent	Gals per Min.	Per Cent	Gals per Min.	Per Cent	Gals per Min	Per Cent	
Positive	6" Crown	.549	0.06	2.6	89.0	9.64	94.3	56	99.6	220	101.2	708	98.54	1109	95.59	With Fish Trap
	6" Nash (broken disc)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	6" Nash	.549	0 0	2.6	55.0	9.64	91.1	55.6	100.1	225	99.0	775	97.5	900	98.2	With Strainer
	6" Union	.549	0.0	2.6	19.9	9.64	68.2	56.5	101.85	226	101.1	623	100.1	1722	99.15	With Fish Trap
	6" Union	.549	0.0	2.6	0.3	9.64	34.4	56.1	98.5	225	101.6	840	99.18	1930	97.8	Without Fish Trap
	6" Union	.549	0.0	2.6	0.8	9.64	70.8	56.6	103.5	227	102.5	837	100.1	1840	99.3	Single Screen
	6" Union	—	—	—	—	—	—	—	—	218	-	615	—	825	-	(Blocked)
Current	6" Crest	.549	0 0	2.6	0 0	9.64	0.0	57	87.3	228	96.9	860	90.5	2063	90.1	Hemp wound in gears
	6" Crest	.549	0 0	2.6	0.0	9.64	91.5	56.6	103.3	226	101.7	852	98.5	2040	98.8	Without Fish Trap
	6" Crest	—	—	—	—	9.64	88.2	56.5	103.5	225	94.2	840	98.5	1905	97.3	With Fish Trap
	6" Gem	.549	0.0	2.6	0.0	9.64	0.0	57	102.1	227	99.78	860	97.57	2200	97.1	With Fish Trap
	6" Torrent	.549	0 0	2.6	0.0	9.64	9.5	57	95.6	228	99.9	843	100.6	1890	92.6	With Fish Trap
	6" Torrent	.549	0.0	2.6	0 0	9.64	52.8	58.2	95.8	223	100.1	828	100.4	1775	99.6	Special tapered Spindle
	10" Torrent	.549	0.0	2.6	0.0	9.64	0 0	56.2	98.42	228	99.53	876	97.1	2465	97.4	With Fish Trap
Devices	4" Detector Meter	.549	100.9	2.6	102	9.64	100.3	58.5	24.3	227	5.2	862	4.1	2100	3.8	Swing Check Valve With 2" Hersey Disc on B.P.
	6" Detector Meter	.549	102.2	2.6	100	9.64	99.5	56	99.7	225	15.15	876	4.74	2490	4.28	Swing Check Valve With 3" Hersey Disc on B.P.
	12" Giant	—	-	—	—	—	—	57	99.1	228	101	885	94.7	2490	99.4	Before change of gears
	12" Giant	—	-	—	—	—	—	—	—	149	102.7	885	102.3	2480	101	After change of gears
	6" Proportional C.V	.549	109.2	2.6	100	9.64	99.5	56.1	99.75	225	18.53	851	14.85	2065	14.85	Vertical Check (Globe Pat.) 3" Hersey Disc on B.P.
	6" Tilden Device	.549	103	2.6	99.8	9.64	99.9	56.8	99.0	220	77.5	830	25.6	2490	5.8	Hydraulic Gate Valve 4" Hersey Disc on B.P.
	Space Piece	—	—	—	—	—	—	58.8	-	226	-	895	—	2612	—	3 ft 6" W.I Pipe

TABLE No. 2. NOZZLE DISCHARGES FOR DIFFERENT SIZED STREAMS, AND PER CENT. OF METER DISCHARGE TO NOZZLE DISCHARGE.

To illustrate wastes on small streams:

1–16-inch	stream	will	discharge	790	gallons	per	day.
⅛-inch	"	"	"	3 744	"	"	"
¼-inch	"	"	"	13 881	"	"	"
½-inch	"	"	"	81 792	"	"	"

The cost of such flows at 12 cents per 100 cubic feet, the average price of metered water at Lowell, would be, for a year,

1–16-inch	stream	$46.16
⅛-inch	"	218.79
¼-inch	"	811.20
½-inch	"	4 779.92

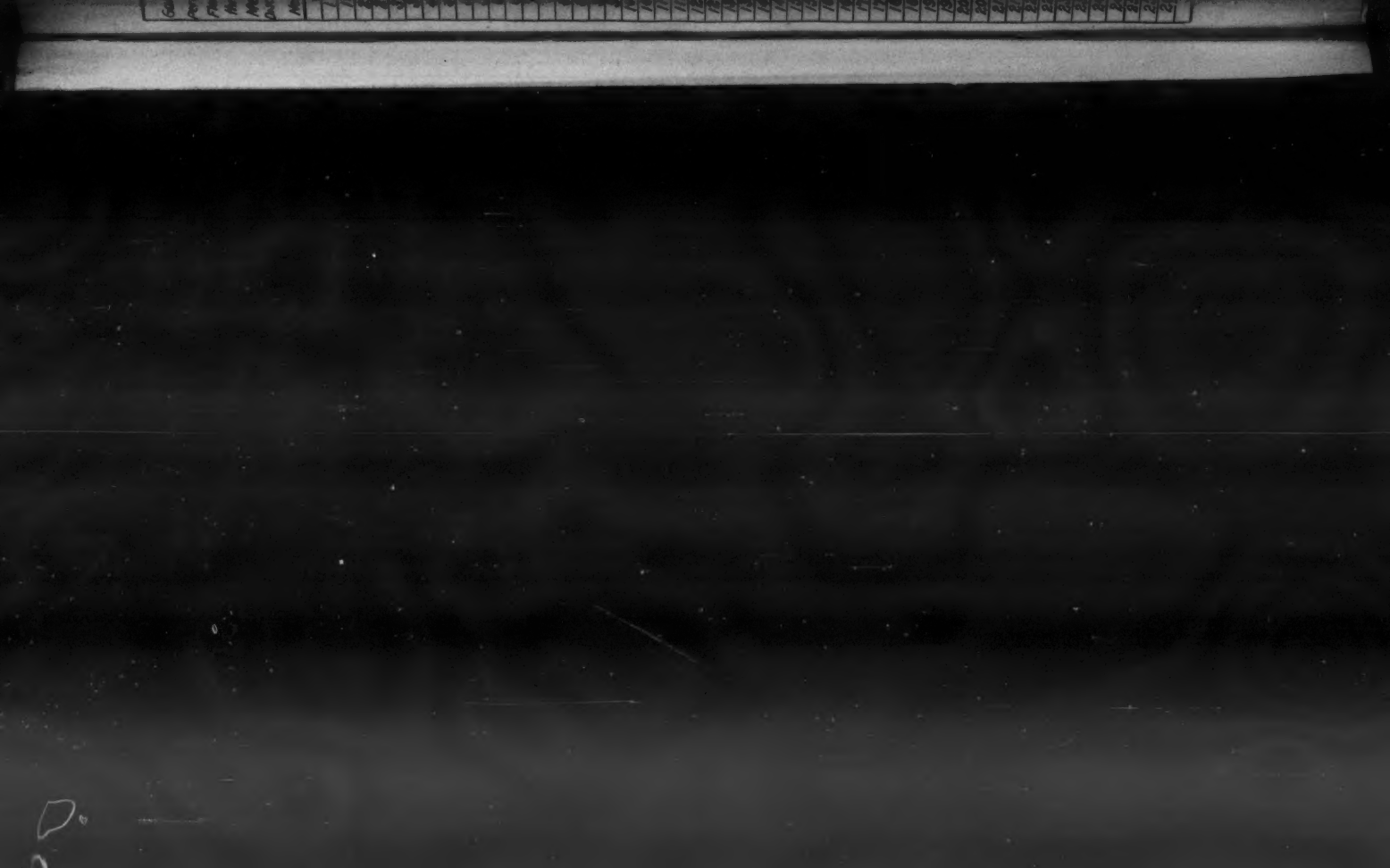
showing that many small wastes could become burdensome to a department. Then, how can current meters be used and at the same time get the record of the small wastes?

As a suggestion, one way would be to set a current meter of known efficiency that will record the flows above a certain amount, but before this meter is set and while the pipe line is cut for such setting, or, better still, if a reliable gate valve is convenient, place a small meter on a by-pass or loop for a time, and by this means obtain the small inherent wastes of the private system, and apply this as a constant to the current meter.

Third. The 6-inch special fire-service devices, so called, are expressly made to register the deceptively small streams and to record wastes or uses up to the opening point of such device; beyond that the devices presented could only indicate that the gate or check had opened, but the degree and duration of such opening could not be recorded.

The competency of these devices may be shown by the following facts — the available supply of water through the apparatus for testing was 2 612 gallons per minute.

The 6-inch Tilden Device was capable of delivering	95 per cent.
The 6-inch Swing-Check Device was capable of delivering	95 per cent.
The 6-inch Globe Check Device was capable of delivering	79 per cent.
The 4-inch Swing-Check Device was capable of delivering	80 per cent.



Gallons Per Minute Flowing through Meter Discharged at Nozzle	Spools Pieces 3-4" & 1" Pipe	Positive Meters							Current Meters							Meter Devices					
		6" Crown Meter With Fish Trap	6" Nash Meter Disc Taken out	6" Nash Motor With Fish Trap	6" Union Meter With Fish Trap Double Screen	6" Union Meter Without Fish Trap	6" Union Meter With Fish Trap Single Screen	6" Underfeed With Fish Trap Single Screen	6" Crest Meter With Fish Trap	6" Crest Meter Without Fish Trap	6" Crest Meter Without Fish Trap Inter-changed	6" Gem Meter With Fish Trap	6" Torrent Meter With Fish Trap	6" Torrent Meter With Fish Trap Horizontal Strainer	10" Torrent Meter With Fish Trap	4" Detector Meter (Swing Check)	6" Detector Meter (Lift Swing Check)	18" Giant Meter June 1, 1914	18" Giant Meter June 2, 1914	6" Proportional Check Valve (Globe Pattern)	6" Tilden's Hydraulic Gate Valve
50	.005	0.2	0.05	0.5	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.25	0.3	0.0	0.0	0.0	0.6
100	.010	0.4	0.20	0.6	0.1	0.0	0.10	0.7	0.1	0.0	0.0	0.0	0.1	0.1	0.00	0.30	2.2	0.0	0.0	0.0	1.3
150	.015	1.0	0.40	0.8	0.2	0.1	0.2	1.7	0.2	0.1	0.1	0.1	0.2	0.2	0.05	0.35	0.2	0.0	0.0	0.1	3.7
200	.020	1.6	0.70	1.1	0.3	0.2	0.33	3.1	0.3	0.2	0.2	0.15	0.35	0.35	0.07	0.40	0.22	0.0	0.0	0.2	4.0
250	.025	2.5	1.00	1.3	0.5	0.35	0.50	5.0	0.4	0.3	0.3	0.2	0.5	0.6	0.10	0.45	0.23	0.0	0.0	0.3	5.2
300	.030	3.6	1.40	2.0	0.8	0.5	0.70	7.0	0.55	0.4	0.4	0.35	0.8	0.9	0.14	0.55	0.24	0.1	0.1	0.4	5.5
350	.035	5.0	2.00	2.7	1.1	0.7	1.00	9.0	0.75	0.5	0.5	0.4	1.1	1.2	0.20	0.75	0.26	0.15	0.15	0.5	5.7
400	.040	6.4	2.60	3.6	1.6	1.0	1.30	12.2	1.1	0.7	0.6	0.5	1.3	1.6	0.25	1.00	0.28	0.2	0.2	0.6	5.9
450	.045	8.0	3.20	4.5	2.0	1.3	1.70	15.1	1.3	0.9	0.9	0.6	1.7	2.0	0.30	1.20	0.30	0.25	0.25	0.9	6.0
500	.051	10.1	4.00	5.5	2.5	1.6	2.10	19.3	1.7	1.2	1.2	0.8	2.2	2.5	0.35	1.40	0.31	0.3	0.3	1.2	6.1
550	.057	12.0	5.00	6.8	3.1	2.0	2.50	23.5	2.1	1.5	1.5	1.0	2.7	3.1	0.40	1.60	0.33	0.35	0.35	1.4	6.2
600	.063	14.5	6.00	8.1	3.8	2.3	3.0	28.0	2.5	1.8	1.8	1.2	3.3	3.7	0.45	2.00	0.37	0.4	0.4	1.7	6.4
650	.069	17.0	7.00	9.5	4.3	2.6	3.5	33.0	2.9	2.1	2.1	1.5	3.9	4.3	0.50	2.30	0.41	0.45	0.45	2.0	6.9
700	.076	20.0	8.00	11.1	5.0	3.2	4.0	38.0	3.3	2.4	2.4	1.8	4.5	5.0	0.60	2.70	0.45	0.5	0.5	2.3	7.0
750	.083	23.0	9.10	13.0	6.0	3.8	4.6	44.0	3.8	2.8	2.7	2.0	5.1	5.8	0.70	3.00	0.50	0.55	0.55	2.7	7.2
800	.090	26.0	10.20	14.9	6.8	4.2	5.2	50.0	4.4	3.2	3.0	2.2	5.8	6.1	0.85	3.30	0.56	0.6	0.6	3.1	7.4
850	.097	29.0	11.50	16.2	7.6	4.8	5.8		5.0	3.6	3.4	2.5	6.5	7.5	1.00	3.70	0.60	0.65	0.65	3.5	7.7
900	.104	33.0	13.1	18.6	8.3	5.4	6.6		5.6	4.0	3.9	2.8	7.2	8.4	1.15	4.10	0.60	0.8	0.8	3.9	7.9
950	.118	36.5	14.7		9.1	6.1	7.6		6.2	4.4	4.4	3.1	8.0	9.3	1.30	4.50	0.64	0.95	0.9	4.3	7.7
1000	.132	40.8	16.1		10.2	6.8	8.2		6.9	5.0	4.8	3.4	9.0	10.2	1.45	5.00	0.68	1.1	1.1	4.8	7.4
1050	.146	44.3	18.0		11.2	7.5	9.1		7.6	5.5	5.2	3.7	10.0	11.2	1.60	5.50	0.70	1.2	1.2	5.2	7.3
1100	.160	48.0	19.7		12.7	8.1	10.1		8.3	6.0	5.7	4.0	11.0	12.3	1.75	6.10	0.80	1.3	1.3	5.7	7.2
1150	.174		21.4		14.0	9.0	11.1		9.1	6.5	6.2	4.3	12.0	13.7	1.90	6.60	0.90	1.4	1.4	6.2	7.1
1200	.186		23.3		15.1	9.9	12.1		10.0	7.1	6.8	4.6	13.0	15.0	2.05	7.10	1.00	1.55	1.55	6.9	7.1
1250	.200		25.1		16.2	10.5	13.1		10.9	7.7	7.4	5.0	14.0	16.0	2.20	7.70	1.10	1.7	1.7	7.6	7.0
1300	.220		27.9		17.9	11.4	14.1		11.8	8.3	8.0	5.4	15.1	17.2	2.35	8.30	1.20	1.85	1.85	8.1	7.0
1350	.240		29.5		19.0	12.2	15.1		12.7	9.0	8.6	5.9	16.3	18.8	2.55	9.00	1.30	2.05	2.05	8.9	7.0
1400	.260		31.8		20.8	13.1	16.9		13.6	9.8	9.2	6.4	17.8	20.2	2.75	9.70	1.40	2.2	2.2	9.5	6.9
1450	.280		34.1		22.0	14.1	17.6		14.5	10.5	9.9	6.9	19.0	21.8	3.00	10.3	1.50	2.35	2.35	10.2	6.8
1500	.300		36.5		23.9	15.2	19.0		15.5	11.2	10.6	7.2	20.7	23.4	3.20	11.0	1.60	2.5	2.5	10.9	6.7
1550	.314		39.0		25.0	16.2	20.4		16.5	11.9	11.3	7.8	22.0	25.0	3.40	11.7	1.70	2.65	2.65	11.6	6.6
1600	.328				27.0	17.3	21.8		17.6	12.6	12.0	8.3	23.3	26.8	3.70	12.4	1.80	2.80	2.80	12.2	6.5
1650	.342				28.8	18.4	23.1		18.8	13.7	12.8	8.9	24.9	28.4	3.90	13.1	1.90	3.0	3.00	13.1	6.4
1700	.356				30.8	19.7	24.5		20.0	14.5	13.7	9.3	26.2	30.0	4.10	13.9	2.00	3.2	3.2	13.9	6.2
1750	.370				32.8	20.9	25.9		21.1	15.3	14.5	10.0	28.0	32.0	4.30	14.7	2.10	3.4	3.4	14.8	6.1
1800	.384					22.1	27.4		22.3	16.0	15.5	10.5	29.8	33.9	4.50	15.5	2.20	3.6	3.65	15.7	6.1
1850	.400					23.2	29.1		23.7	17.0	16.3	11.1	31.4	35.5	4.80	16.3	2.30	3.8	3.80	16.6	6.0
1900	.420					24.7			25.0	18.0	17.1	11.7	33.0	37.5	5.10	17.1	2.40	4.0	4.0	17.5	6.0
1950	.440					26.0			26.5	19.0	18.0	12.3			5.30	18.0	2.50	4.3	4.3	18.4	5.9
2000	.460									20.0	19.0	13.0			5.60	19.0	2.70	4.6	4.6	19.3	5.9
2050	.480									21.0	20.0	13.6			5.90	20.0	2.90	4.8	4.8	20.2	5.8
2100	.500											14.2			6.20	21.0	3.00	5.0	5.0	21.1	5.8
2150	.530											15.0			6.50		3.20	5.2	5.2		5.6
2200	.560											15.8			6.90		3.40	5.4	5.4		5.5
2250	.590														7.20		3.60	5.6	5.6		5.4
2300	.620														7.40		3.70	5.9	5.9		5.3
2350	.650														7.70		3.90	6.2	6.2		5.2
2400	.680														8.00		4.00	6.4	6.4		5.1
2450	.710														8.40		4.10	6.7	6.7		5.1
2500	.740														8.80		4.20	7.0	7.0		5.0
2550	.770																				
2600	.800																				

TABLE NO. 3. RETARDATION OR LOSS OF PRESSURE IN WATER METERS.

The same devices retarded the flow of water more than a straight piece of 6-inch pipe, as follows:

The 6-inch Tilden Device. . . .	625	per cent.	or	1	to	6.25
The 6-inch Globe Check Device .	2 581	„	„	1	„	25.81
The 6-inch Swing-Check Device,	525	„	„	1	„	5.25
The 4-inch Swing-Check Device,	2 625	„	„	1	„	26.25

These figures show that some of the special devices can be depended upon to deliver more water with less loss of pressure than either the positive or current type of meter; that the devices are capable of recording the flows for which they are adjusted, but beyond such adjustment the flows can only be approximately accounted for.

In conclusion, we believe that if metering appliances were placed on all private supplies it would effectually put a stop to chronic wastes, and, in our opinion, there would no longer be any need for the department to supervise and inspect the fire service beyond such device, placing upon the parties protected by these fire services the responsibility of ascertaining the inherent leaks of the hidden portions of the fire-service system; for, undoubtedly, the party having to pay the bills will be inclined to stop such wastes, even to the extent of relaying and renewing the underground furniture and fixtures.

Whether or not we have partially fulfilled the expressed purpose of these tests, which was to discover, if possible, some practical mechanism to regulate and account for water taken from the distribution system — whether or not any of these meters or devices will satisfy the water-works people and fire underwriters, we will leave to the opinion of those interested in this important subject.

DISCUSSION.

Mr. Edward Atkinson.* It is such a discussion as this which justifies me, as an underwriter, in being a member of this Association. I appreciate to the fullest extent the extreme value to the mutual underwriters, whom I represent, of this investigation in Lowell, with which we are perfectly familiar. It reminds me,

* President, Boston Manufacturers Mutual Insurance Company.

however, of the tests of the ships of war which they have to pass in order to be accepted. They reach the required speed after every possible provision has been made, and are accepted. After that, in practice, they very rarely, if ever, attain any such speed, the conditions in practice being so thoroughly different from the conditions in such a carefully prepared test.

I wish to correct one error, if I may call it so, that but one fire service is needed. We represent the largest part of the large factories and workshops of the New England and Middle States and many others. Not in one case in one hundred do we accept a single supply of water. In many of the larger cities a double supply of water is required, and in many of the larger cities a double fire service.

Now, it turns out even in these refined tests that meters got clogged, that they broke, and that they did in some instances make an appreciable and what might be a disastrous reduction in the pressure. Bear in mind that in the emergency of a fire there come sudden changes of pressure, sudden conditions of emergency, and it goes without saying that any apparatus of any kind, however constructed, however well made, under those conditions may break and may prevent the saving of property. Our end is the same. Is it more important to the community to save a little water that might otherwise be wasted, or to save the property on which the whole welfare of the community may depend? There we come together.

Reference has been made to Mr. Freeman. When I first began my practice there was nothing but empiricism in pumps, pipes, hydrants, hose; and Mr. John R. Freeman was brought into the service of the mutual underwriters in order to bring about scientific results, and to bring these matters to the condition of applied science. Whether he was well chosen or not, his works have told. There has been no question of greater difficulty than the adjustment of the relations between underwriters of our kind, for the welfare of the community, and of the owners of factories, and the water-works engineers whose duty it is to save the water. In some cases, very rarely indeed, they have been so obstinate in demanding meters where they should not be installed, that the owners have dropped the public supply of water entirely, and

have put up their own independent works with their double supply of water. As a rule we rarely have any difficulty in getting a by-pass or in so arranging the meter that our fire service shall not be interrupted by any complex mechanism or any of the clogging that is liable to happen at any time except during such an experimentally refined test as has been described. The finality, unless it can be made satisfactory, simply is that we withdraw our policies. We have no money to make, all we aim to do is to save the community and the factory, and if they do not choose to accept our conditions, we simply withdraw our policy. We have nothing to sell.

Now, when the water-works engineers convince Mr. Freeman and my vice-president, Mr. Gray, and Mr. French who is here, that a meter can be put into a fire pipe without a by-pass, or without getting around it in some way, so that it shall be as safe with it in the fire service as without it, then we may accept it. Until then we mutual underwriters, who have fifteen hundred millions of property running from a minimum of 100 000 on a risk up to six or seven millions, stand in the way of the adoption of meters in a fire service, and shall continue to get around them, evade them or do without them, or do away with the water works which insist upon them. Our interests are identical, and the question is, will you save the most by saving a little water by putting in a meter, or will you save the welfare of the community by meeting that waste in some other way, as it has been met by Mr. Coggeshall in New Bedford, without impeding the fire service?

THE PRESIDENT. We have a very long program for the afternoon, and it has been suggested that discussion of this paper be held over until our next meeting, and that we proceed now with the other papers. This paper will then be before you in print, and you can discuss it more fully.

[September 13, 1905.]

MR. SULLIVAN. At the meeting in March, after the reading of the paper and the conclusion of the remarks of the gentleman who was discussing it, as I was about to reply, the President said, "We have a very long program for the afternoon, and it has been

suggested that discussion of this paper be held over until our next meeting."

At the former meeting Mr. Atkinson, in discussing the tests at Lowell, referred to the acceptance tests of warships. Now, gentlemen, I believe the results at Manila and Santiago justified the government in accepting warships after trial tests, and Captain Clark's memorable trip on the *Oregon* proved conclusively that a war ship in practice can measure up to a warship in theory.

It seems to me, however, that there is no very close analogy between the duties of a warship and a meter, between the speed of a boat and the capacity of a measuring device, the efficiency of the engines and the registration of a meter; but, like the tests of warships, the test of meters will show which is most suitable for special work. Again, ships of war are either accepted in entirety or provisionally, and are sometimes rejected on account of such tests. In the tests at Lowell, the meters were neither accepted nor rejected, but an honest endeavor was made to obtain facts that would assist and enlighten the department, and as some members of this Association were interested in the results, I was requested to prepare this paper.

I do not believe the experiments could be called "a carefully prepared test," and the meters and devices tested were either regular commercial meters from stock, in the market for sale, or experimental devices sent to us on account of the facilities we had for testing.

As for the charge of refinement of accuracy, I presume that the meter companies will admit that the machines sent out were well and carefully made; and as for trying to obtain the correct discharges and loss of head due to the meters, we have only emulated the example of the mutual underwriters, who have such scientifically equipped laboratories for testing almost everything employed in the extinguishment of fire. The able and excellent paper by Mr. French shows that they are fully alive to the issue, and cannot only make refined tests of meters, but can design and manufacture such a meter as Mr. French has described here; and I assure you I think he is modest in his claims with regard to its performance. It seems to me that it is such a meter as has long

been sought for by the different interests, and will supply a long-felt want.

Mr. Atkinson in his remarks said, "I wish to correct one error, if I may call it so, that but one fire service is needed." It must be that the gentleman misunderstood me. I said, "Out of one hundred and twenty-four fire services in Lowell only one was metered," and that was true at the time. Since then others have been added.

Mr. Atkinson, continuing, said, "It turned out even in these refined tests that meters got clogged, that they broke, that they reduced the pressure, etc." Why, that was part of the object and aim of these tests, to gather just such information, and I believe it is the object and aim of the underwriters to get such information.

Mr. Atkinson further says, "It goes without saying that any apparatus of any kind, however constructed, however well made, may break and may prevent the saving of property." Granting that, is the chance of a properly constructed meter breaking down and being a menace any greater than the chance of a valve being closed or failing to operate, a hydrant not opening, fire pumps not doing their duty, sprinkler-heads failing to open at the proper time or the piping systems failing to withstand the pressure? Mark you, gentlemen, there was no time during the tests, whether a meter clogged or broke, that the supply of water was entirely shut off.

Now, in regard to the welfare of the community, and looking at it from the road, as it were, it strikes me that water-works managers have the welfare of the community as much at heart as any other body of men.

I do not believe it was the intent of the Lowell Water Department to install a testing apparatus to make any series of refined tests. It was rather to install a practical and useful apparatus that can be used at any and at all times for testing large meters.

Professor Bemis spoke about the effect of water-hammer on the Hersey Detector Meter. We made a series of tests both on the experimental and improved detector meter; and the water for these tests was taken from a pipe line supplying a high-service pump, pumping direct to the high-service system, during a portion of the year. This pump had a regulator, and relieved itself

through a relief valve located in the basement of the engine room, thus making the conditions favorable for water-hammer. On every occasion when the check was once closed it remained closed, and no water-hammer was experienced sufficient to open it. I believe that the by-pass furnished sufficient compensation to keep the clapper on its seat.

FIRE-SERVICE METERS.

BY E. V. FRENCH, ENGINEER AND INSPECTOR, ASSOCIATED FACTORY MUTUAL INSURANCE COMPANIES, BOSTON, MASS.

[*Read September 13, 1905.*]

Several years ago, after many discussions, in this Association and elsewhere, of the problems which the private fire service causes, we came to the conclusion that the best solution of all of the difficulties would be a meter which would measure *all* the water passing through the service, but which could not seriously obstruct the flow. There was no meter on the market fulfilling these requirements and there appeared no immediate prospect of one being developed. As we felt that something must be done soon, we started to devise a meter for this work.

We believed then, and we still believe, that there are many cases where it is not yet necessary to put on a meter to prevent improper use of water from the fire system. We have therefore felt justified in urging that simpler means be adopted for the present in all cases where conditions are favorable. Later, when devices now promising well have been proved by experience to do the work satisfactorily there will be little objection, other than the cost, to the somewhat general equipping of fire services where there is considered to be a real need of it.

Some form of proportional meter seemed the most hopeful direction for a solution of the problem. We have made, and others have made, many experiments using an ordinary check valve having a by-pass around it with a meter in the by-pass. This arrangement would measure large flows with reasonable accuracy, but it would not measure small flows, and, moreover, the factor by which the reading of the by-pass meter must be multiplied to give the total flow was a varying quantity during the time that the check valve clapper was opening.

In searching for a remedy for these difficulties, we hit upon the idea of connecting in some way the action of the by-pass meter

with the raising of the check valve clapper, so that the multiplying factor would be automatically corrected, and thus give a true reading at all flows. The working out of this idea has proved to be *one* way of making a meter which can be safely used on fire mains, and which will measure small as well as large flows with sufficient accuracy for all practical purposes.

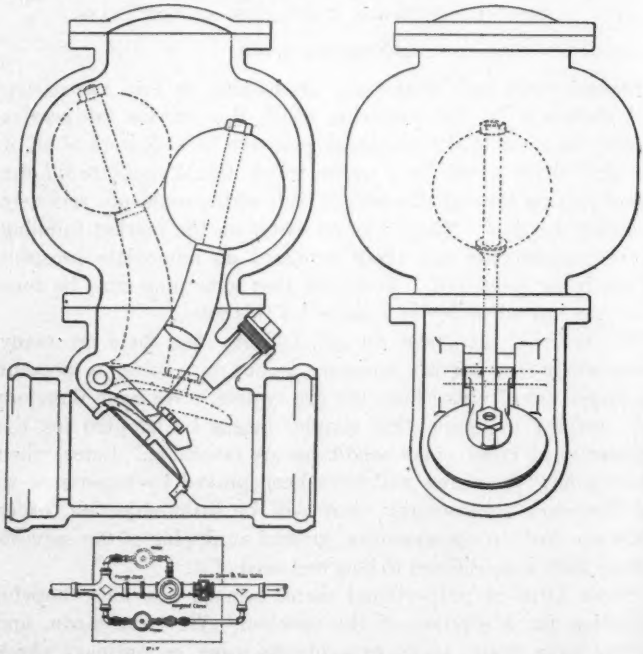


FIG. 1. WEIGHTED CHECK VALVE.

In seeking a method of taking care of the very small flows, we suggested in several instances putting a considerable weight on the clapper of an ordinary check valve, replacing the usual cover plate by a dome. Fig. 1 shows this idea. The thought was to so arrange the weight that it would exert a large force tending to hold the clapper on to its seat, but that as the clapper opened,

the weight tended to go toward the center, thus reducing the friction loss which the weight causes. This device would, of course, not measure the large flows at all, and would simply be useful as a means of getting at the small flows, but could, perhaps, be arranged with some simple seal or other indicating arrangement so that it would show whether the clapper had been off its seat or not. We suggested this in a few instances as a possible temporary expedient until a better device was available; but as we studied the problem it seemed to us (and the advice of several water-works men who have carefully considered this matter for years was in the same direction) that for the best results, taking it year in and year out, the ideal fire-service meter must be able to measure all flows,— the small as well as the large. We therefore set for ourselves the goal of getting a device which was truly a meter and which would reasonably record the smallest flows which any meter can detect, and equally well the largest flows which could be drawn through the fire-service connection.

After much designing, many experiments, and the discarding of ideas once promising, we built a 6-inch meter along the following lines:

First, there was a check valve of special design but of the usual type, except that all parts were made more substantial. The clapper of this check valve closed against a seat having an annular groove open to the atmosphere and giving a differential of about 6 per cent.; that is, the pressure on the down-stream side of the clapper must be about 6 per cent. lower than the pressure on the up-stream side before the clapper would open, this being due, of course, simply to the difference in areas on the two sides, the down-stream side having the greater area. A considerable weight was put on the clapper to insure its proper operation and to firmly force it on to its seat. Around this check valve a 3-inch by-pass with 3-inch disk meter was placed and a screen of large area, arranged to be washed clean by the current through the main channel, was provided; also a check valve in the 3-inch by-pass to prevent water going from the fire protection equipment back into the public mains. We then introduced a controlling valve, known as the "horn," which is attached to the check valve clapper, and which works in a hole through which the water from the

3-inch by-pass discharges on the down-stream side of the clapper. By experiment we filed this horn into such shape that it made the factor or coefficient, by which the reading of the meter must be multiplied to get the total flow, a constant for all rates of discharge. We found that this controlling horn would govern the water reliably and with sufficient closeness for ordinary practical work.

A measure of the small flows was obtained by holding the clapper of the check valve on to its seat by the differential action and by the weight until there was about 130 gallons flowing through the 3-inch by-pass, with which flow the loss of pressure through the by-pass was just about sufficient to cause the opening of the check. In this way, all flows up to about 130 gallons per minute were measured with all the accuracy of a 3-inch disk meter, which, it was believed, was sufficiently sensitive for any purpose.

It is desirable that one meter measure all the flows, and this was accomplished by letting the 3-inch meter measure the flows directly up to about 130 gallons, and then arranging a second dial which by a simple arrangement of levers was thrown into action the instant the main clapper opened. Having by the horn made the coefficient a constant for all flows, it was, of course, entirely possible to arrange the second dial so that it multiplied the readings of the 3-inch meter by the coefficient, thus letting the one 3-inch meter measure, first directly and second proportionately, all the water flowing. As worked out, the ratio between the main channel and the 3-inch by-pass is such that ten times as much water goes through the main channel as through the by-pass. The total quantity, therefore, is the sum of the readings of the two dials.

This first experimental meter, which may be seen at the left in Plate I, Fig. 1, was finished about January 15, 1905, and proved to us that this was one method, — not necessarily the only one and not necessarily the best one, but one way of metering a fire service. Feeling sure, therefore, that the main principles had been established, we redesigned the meter, with the idea of bringing it into compact and commercial form. The first meter had naturally been experimental, less compact than desirable, and many changes have been necessary as the experiments developed. The second

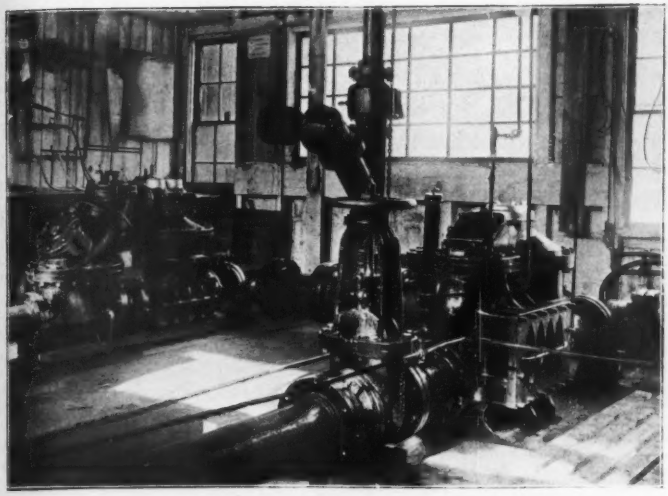


FIG. 1. FIRST AND SECOND MODELS OF PROPORTIONAL METER.

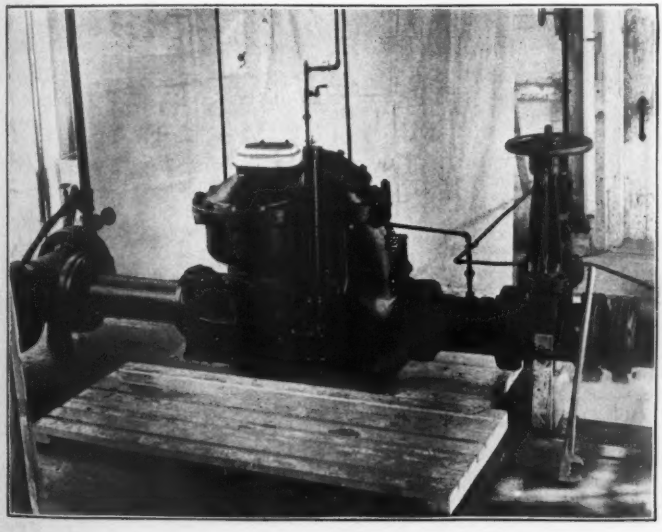


FIG. 2. SIX-INCH PROPORTIONAL METER.

meter, which is now completed, follows the same general lines but is in better form; an external view of it is shown in Plate I, Fig. 2, and also at the right in Plate I, Fig. 1, and a sectional elevation in Fig. 2. In this meter the clapper and attached parts are made heavy and the lead weight is about 48 pounds, so that a large and positive force is tending to hold the clapper

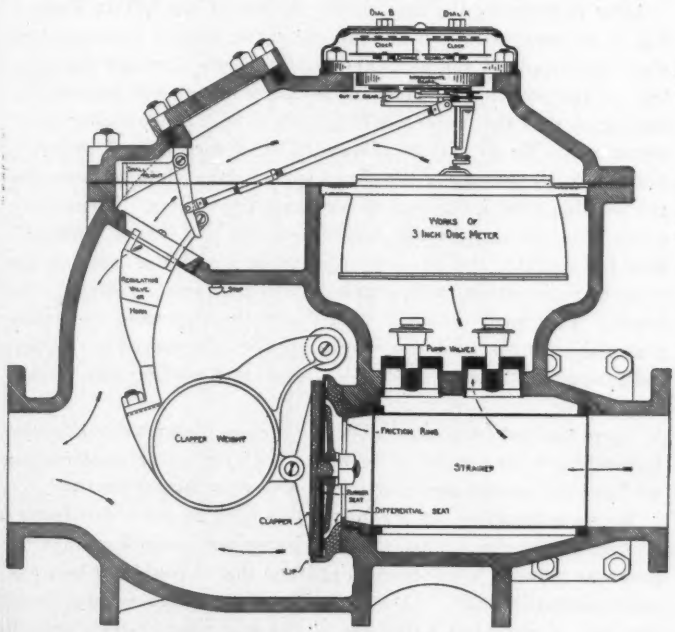


FIG. 2. PROPORTIONAL METER.

on to its seat. The annular space of the seat is open to the atmosphere and the differential action is less than 6 per cent.; that is, with a static pressure of 80 pounds the clapper would remain on its seat until the pressure on the fire-service side had dropped to about 75 pounds. It then leaves its seat with a jump, which jump is increased by the small lip surrounding the clapper, and this throws the horn into the discharge orifice from the by-pass,

and at the same time throws the second dial into gear, and the meter will register all flows proportionately from this point on. The horn corrects the coefficient while the clapper is opening, and experiments show that after the clapper reaches its stop, the coefficient is practically a constant for all further flows, at least within the ordinary range of commercial use.

After completing the first meter, shown at the left in Plate I, Fig. 1, we arranged it in the laboratory at Lowell in connection with the supply of the locks and canals, where, through the courtesy of the proprietors, excellent facilities are at our disposal for testing, so that the meter would get the almost exact conditions of actual use. To do this we allowed a small flow, 4 or 5 gallons a minute, to go through it for about two months, thus representing the possible small leakage of the ordinary fire system. Then about every week we ran through larger flows up to 1 000 or 1 500 gallons per minute, and at each time made a series of tests on the ratio of registration to flow when reading proportionately. The results from week to week varied slightly, but were all within reasonable limits, and are shown in the diagram, Fig. 3, thus indicating that the method of proportional reading was reasonably stable.

There has not been time since the second meter was completed to carry on a long series of tests, but with its better construction we have full confidence that it will give even better results.

We were troubled for a considerable time to get a satisfactory closing of the check, the tendency being not to re-seat until the flow was reduced to so small an amount that it could not be measured proportionately. After considerable study, we developed the idea of providing a ring around the seat about $\frac{1}{8}$-inch larger in diameter than the clapper, and then making the horn long enough so that when the clapper first jumps open it throws the horn a short distance into the orifice. The ring gives the clapper a larger opening at the start as the water forces it, the moment it leaves its seat, to the outer edge of the ring. The part of the horn thrown through the ring at the start keeps the proportional reading accurate down to the point where the clapper re-seats, which is, in the device as it stands, with about half the flow occurring at the opening point. As now arranged, the device will quite accu-

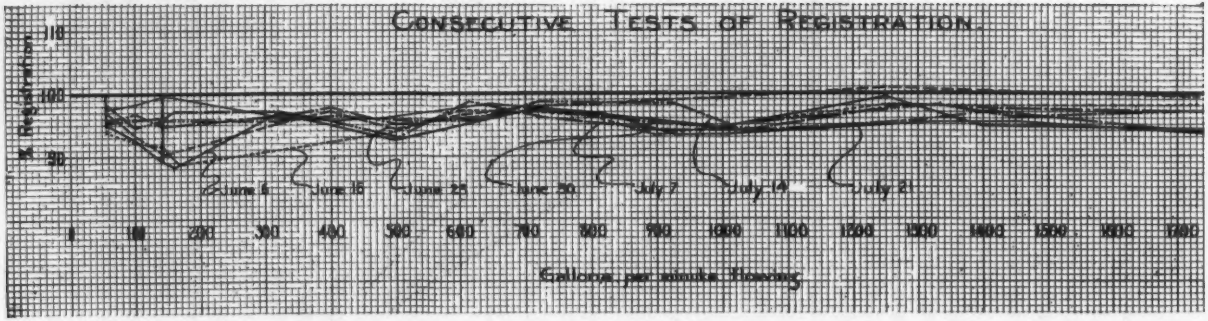

Consecutive Tests of Registration.
Registration
118
100
90
June 6
June 16
June 25
June 30
July 7
July 14
July 21
1
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
Gallons per minute Flowing

Fig. 3.

rately measure the water down to the closing point, thus covering all flows.

The device has the merit of requiring only one small meter for both small and large flows, and as the arrangement works, this meter is thoroughly washed out by a considerable flow going through it directly before it is called upon to measure water proportionately. This feature alone will be a considerable factor in insuring that any slight obstruction will be removed before the more delicate proportional reading commences. Again, with the two dials, a very good idea can be obtained as to the approximate rates of flow through the meter — a thing in some instances of value in controlling fire services. This is possible from the fact that the 3-inch meter measures on dial A the water coming through the by-pass, and on dial B the water coming through the main channel. If, therefore, for example, at the end of a month the total quantity is small and is all shown by dial A, it will indicate that all water going into the fire system went in at a low rate of flow. If, on the other hand, dial A shows but a small part and dial B most of the quantity, then it will indicate that the drafts were at a higher rate of flow. In the event of a fire on a service where the record on dial B was surely due to fire alone, — that is, there had been no other large drafts, — the water used during the fire would be the reading of dial B plus 1-10 of the reading, the tenth being simply due to the water which had gone through the 3-inch by-pass. In this way it would be very easy to deduct from the total flow for the month or quarter the amount which the fire caused and for which there would ordinarily be no charge.

The arrangement of the screen protecting the 3-inch meter is such that every large flow through the main channel would tend to wash off a considerable part of any accumulation, thus, in a way, making the thing self-cleaning. It is, of course, recognized that any large metering device must have some reasonable care, especially where poor waters are used, to be sure that it remains in working order. The whole thing has been designed in a simple and rugged manner, and with all parts readily accessible. The large weight, as suggested previously, insures the tight closing of the clapper under all ordinary conditions, while if any considera-

ble obstruction should get under it, the constant flowing of water from the annular space would at once give indication that the meter was out of order.

In the chart, Fig. 4, the lower curve shows the friction loss of the present meter (Fig. 2 and Plate I, Fig. 2) as it stands to-day. We strove to keep the friction loss as small as possible but found a moderate loss necessary for the successful operation of the device. The meter has, however, one very good feature, in that the loss does not increase rapidly at the large flows, this being

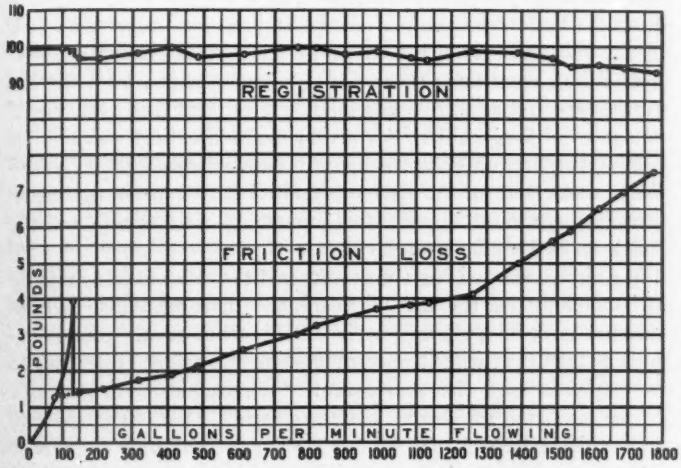


FIG. 4.

due to the fact that after the check valve reaches its stop, the loss is comparable with that of the ordinary check valve, the larger comparative loss at the lower flows being simply due to the weight.

The upper curve in Fig. 4 shows the degree of accuracy of the readings of the device, — at first when the by-pass meter is reading directly, and then when the whole device is working proportionately. The water in these tests was measured by nozzles in the usual manner. It will be seen that the registration, while

reading proportionately, is sufficiently close for all practical purposes.

Considering that this meter was mainly for fire services, through which there should normally be no draft, we have felt that the small waste from the differential space, which at 70 pounds pressure amounts to but 8 or 10 gallons per minute, was not objectionable. In a fire this small loss of water would not appreciably reduce the fire supply. Of course, with a meter of this kind there would be no serious objection to the occasional use of some water in a mill yard in an emergency, as in the case of the breaking down of a boiler feed pump, a condenser, or other similar use which in the past has given the water-works superintendent anxiety. Under such conditions there would be some waste from the annular space, but as these uses would be infrequent this waste would not seem objectionable. An arrangement has been devised for cutting this flow off when the meter is passing considerable quantities of water, but for the present it seems better to allow the waste, thus getting the full benefit of an immediate indication in case the check valve does not properly seat.

We have been pushing the development of this meter as rapidly as possible during the last few years, and those who have had experience in developing any device of this kind, or any general experimental work, will at once appreciate the many difficulties to be overcome and the considerable time necessary in getting a device into even reasonably complete form. It is our purpose to make this device available for any one for fire purposes in the near future.

We have watched with much interest the development of the Hersey Detector Meter. We have discussed the problem on many occasions with the manufacturers, have received useful suggestions from them, and have made available for common use some points brought out in our own experiments, for we have kept clearly in mind throughout all of this work that the chief aim was to get upon the market and have available for all a simple and reliable meter which could safely be used, and which would be acceptable to water departments on fire-service connections where some measuring or detecting device was imperative. The Hersey Detector seems to us to be available for many places and

is not objectionable from an insurance standpoint. It does measure the small flows and indicate reliably the large ones, giving a fairly good idea of the time in which large flows were going on. It further gives immediate notice whenever the clapper is off of its seat.

From a fire protection standpoint, it is in general objectionable to have water drawn from the fire pipes for manufacturing purposes. Such drafts, especially where considerable, mean that before fire pumps can produce a higher pressure for hose streams and sprinklers, it is necessary that they should discharge enough water to feed all the mill supply connections which may be open, and this often at a considerably higher pressure and consequently larger flow than when fed by city water. It is therefore our strong preference to have *fire pipes used only for fire purposes*, and under these conditions a meter which will measure small flows, thus recording the leaks in the system or any occasional small uses, and which will indicate the larger ones, would seem under many conditions to cover all the needs. We have, therefore, been advising the use of the Hersey Detector during the last few months, and in a similar way should be ready to recommend any equivalent device.

Our present position in regard to fire service where some improvement over existing conditions is desired is as follows:

(1) Ask the mill people to cut off every connection taking water for manufacturing purposes from the fire pipes.

(2) Put on a Hersey Detector Meter and have the mill people clearly understand that they must not draw water through the fire-service pipes, except in the case of fire and for such periodical testing as may be agreed upon with the water department.

(3) If the water department feel that a meter measuring all flows is necessary, we hope that the device which we have developed, and which has just been described, can soon be made available, and of course could be put on in any case where preferred.

We believe, therefore, that a distinct advance has been made, and that it is to-day feasible to put a guard over the fire service which with reasonable care will give the water department full knowledge of what is going on and full protection against any improper taking of water. It is, of course, recognized that a

meter such as we have attempted to develop, which will measure all flows, would be the best possible thing, in that it would leave no opportunity for dispute, for whenever a protected mill drew water through the fire pipes, either properly or improperly, the matter could be at once adjusted by the rendering of a bill with no argument as to why the water was drawn or as to the amount drawn.

It has occurred to us that to discourage any use of water through the fire system, except in emergencies, it would perhaps be proper to charge for water used in this way, except water used in actually extinguishing fire or any reasonable testing, a little higher rate than for water used through the ordinary mill-service meter.

The National Fire Protection Association, which to-day has representatives from all of the underwriting and most of the allied interests connected with fire-protection work, has appointed a special committee * to consider the whole private fire-service problem, thus showing that the underwriters and fire-protection engineers as a whole are quite alive to this matter, and are desirous of meeting it in a proper and comprehensive manner. This National Fire Protection Association Committee met a committee of the American Water Works Association in the spring and discussed various problems with them, all as shown in the transactions of the American Water Works Association and proceedings of the National Fire Protection Association.

At the joint meeting of the above committees the following resolution was adopted:

"That it is the sense of this conference that an apparatus embodying an indicating check valve which shall not afford an initial resistance greater than about 6 per cent. of the available pressure, with a metered by-pass, will prove acceptable on fire risks to both committees represented in this conference."

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* This committee consists of —

E. V. French, chairman, Associated Factory Mutual Fire Insurance Companies, Boston.
A. Blauvelt, associated manager, Western Factory Insurance Association, Chicago.
J. E. Diebold, inspector, Burrows, Marsh & McLennan, Chicago.
H. A. Fiske, manager, Special Risk Dept., Phœnix Insurance Company, Hartford.
C. B. MacKinney, care Starkweather & Shepley, Providence.
H. L. Phillips, manager, Factory Insurance Association, Hartford.
A. R. Williams, special agent, Union Assurance Society of London, Milwaukee.

This resolution was ratified by the full convention of the American Water Works Association at West Baden, and also at the ninth annual meeting of the National Fire Protection Association held in New York.

It is the desire of the committee to discuss these matters in a friendly way with water-works men, and it is believed that we need the advice and counsel of those practically engaged in handling water supplies to wisely settle the various problems which arise in connection with fire services. This committee is therefore ready to discuss with the committee of this association any problems of this kind at any time, and we believe that there are no difficulties which cannot in this way be satisfactorily overcome.

In closing I desire to make it very clear that the meter which has been developed is the product of our Inspection Department and that valuable ideas have been received from many members of the department, and especially from the following men: Mr. Ezra E. Clark, starting with the idea that there must be a connecting link between the clapper opening and discharge from the by-pass connection, suggested and developed the horn regulating valve and the one-meter idea and worked out the original studies leading to the putting of the whole device together in compact and practical form. Mr. George F. Hiller worked out many important points and designed and built the first meter, and carried through with much patient work the experiments necessary to bring it all into its final perfected shape. Mr. Edw. W. Sibley laid out the main lines of the second meter in its present commercial form, carried it through the shops with much energy, and has given many long days to putting the meter in its present completed form. Messrs. Clark and Hiller have followed the later developments, giving valuable suggestions and advice at various times, so that the whole thing is an excellent example of the advantage of the free coöperation of several men interested in the same problem but getting at it from different directions and with different experiences.

DISCUSSION.

MR. EDWARD W. BEMIS.* I should like to ask Mr. French a question bearing on our experience at Cleveland with the Hersey Detector Meter, which we tried as an experiment. We found with the meter which we placed in the basement of our City Hall, that there was a great deal of water-hammer owing to the elevators in the neighborhood, and this caused a fluctuation much greater than the 6 per cent. It caused the very frequent opening of this clapper and a considerable loss of water through the annular opening every time this occurred. This was such a serious matter that it discouraged us for the time being in the use of the meter; of course we may return to it. I should like to ask Mr. French if he has solved the problem, and how much water is lost — I think he told us but I didn't quite grasp it — in such a case as that, and what he would do where there is considerable water-hammer through elevators, etc.

MR. FRENCH. Our feeling is that perhaps that is somewhat an abnormal or rather an unusually serious condition, and that it would be rather desirable to find a remedy for the water-hammer, for it is pretty likely if it doesn't hurt somebody's meter that it will hurt something else. The amount of water escaping — the orifice would be somewhere between one eighth and one fourth of an inch — would be somewhere between 5 and 10 gallons a minute with a static pressure of 70 pounds. If the water-hammer was simply a momentary jump, I should expect that there would be very little water lost. If it was of a longer surge type the clapper might stay open for half a minute, and perhaps there would be a loss of 2, 3, 4 or 5 gallons every time. We haven't given special consideration to getting over that difficulty, feeling that in the average service such as we are connected with, and where we would ordinarily be at the entrance to a mill yard with considerable pipe beyond us, that would not be a serious matter.

MR. BEMIS. Suppose there was an hydraulic elevator in the mill, would there not be that water-hammer?

MR. FRENCH. There might be that water-hammer and it might occasion some trouble such as you mention. I should think

* Superintendent of Water Works, Cleveland, Ohio.

that in a case like that the placing somewhere of a fairly good sized air chamber would perhaps cover the difficulty. I think it would have to be treated somewhat as a special difficulty in each case, depending on the local conditions.

MR. FRANK C. KIMBALL.* At Mr. French's invitation, and in company with two members of this Association's Committee on Private Fire Services, I had the pleasure of inspecting this meter at Lowell last Saturday. Our time was so limited that we could make no special tests of it, but the tests that had been made I was somewhat familiar with from the fact of having made numerous tests along these lines myself, and I was thoroughly satisfied that the meter would do all that is claimed for it. It seems to me that Mr. French has come nearer hitting what is required along these lines than has been accomplished heretofore. He certainly has a meter which is acceptable to the insurance people, and that is saying a great deal.

Just what the unforeseen is that will happen to this meter, which question has always troubled Mr. French and the other insurance people, I don't know. We will leave them to work that out. From a water-works standpoint, and speaking as one who, perhaps, has looked into this question of metering fire supplies as much as any one, I would express the opinion that this fully meets our desires. As we all know who have used them, any of the present 3-inch disk meters will measure streams, even very small flows, fine enough to satisfy even a hypercritical water-works man: and with this device arranged as it is, so that it measures even at the highest flows within 5 per cent., and, as Mr. French has very plainly shown, can be made to register undoubtedly even closer than that if the game is worth the candle — which I do not think it is — I believe that water-works officials have something so good that they cannot reasonably ask for anything better. This is all on the supposition, which I think is a correct one, that there are no mechanical difficulties in the way of building this apparatus.

I am sure that so far as the companies that I represent are concerned, where I have for some years, as Mr. French very well knows, taken the stand that some device must be used to deter-

* Civil Engineer, Boston, Mass.

mine whether or not water is used properly or not used at all, as they claim frequently is the fact, we are ready to accept the situation and go in with the underwriters on this device, as in fact we have already in one or two instances with the Tilden-Hersey device.

There is one point that Mr. French made as regards not using any water even with this device upon sprinklered mill services, with which we somewhat disagree. We have felt always from a water-works standpoint that some water used through a fire service which was metered was of advantage because it showed whether or not the apparatus was in working order and would respond when it was necessary to call upon it. Of course that is a matter which perhaps is not of serious consequence. If they can induce their mills to put in two connections or three or four in place of one, water departments as a rule, I think, would have no objection. If we should attempt to carry out the suggestion, however, to discourage the use of water through fire-protection fixtures for other than fire purposes by charging a higher rate for water used through such fixtures, I think some of our legal friends would come forward with decided objections which would prevent water departments from so doing.

I am very glad indeed to see the result of what has been done by the underwriters' association that Mr. French represents. Those of you who have heard him discuss this question before undoubtedly recall his remarks as to the device that he was perfecting or getting ready, and I am free to say that some of us, and I was one of them, thought that it was only to stave off the evil day when meters were coming. But I am very glad to find that I was mistaken, and that he has brought out a device that I think we can all adopt. I think we may feel confident that this whole evil of stealing water will be brought very close to an end, at least where politics do not interfere to prevent. Not only are the Factory Mutual companies entitled to a large amount of credit for this, but I think that this association, and as well the American Water Works Association, can take a good deal of credit to themselves for forcing the companies to produce something to accomplish the end for which we have been seeking. If we had kept quiet and waited for Mr. French to have developed

this in his own good time, it might not have been developed within the next — well, six or eight months at least.

THE PRESIDENT. We should like to hear from Mr. Tilden.

MR. J. A. TILDEN.* Mr. President, I did not expect to have anything to say to-day, particularly as, being an associate, I have no claim on your time. I should like, however, if you please, to correct, not what Professor Bemis has said, but to correct an erroneous impression which I fear has been derived from what he did say. The Hersey Detector Meter to which he referred was not of the commercial form. Professor Bemis up to the present time has never had nor seen, except in the exhibition room here, a commercial form of the Hersey Detector Meter. What we did do was to send to him at his request what we then had on hand, which was a detector meter in the process of development. This meter is fully explained in Mr. Sullivan's paper (printed in this issue of the Journal), and which you will notice is there marked "4-inch swing-check device (experimental)." That is the one which Professor Bemis had, a style which has been entirely abandoned. It was one of the earlier experiments.

I think I risk little in saying that in all the series of experiments at Lowell, extending over many months, and that in all the record of use,— and I can see gentlemen here who have these meters in actual service under most severe water-hammer,— no one has ever known of such a thing or heard of such a thing as the check unseating from water-hammer. The detector which Professor Bemis had was not set on a service leading to the building. It was set on a pipe leading off the service and passing to a dead end, where if there was any disturbance at all it would be felt in intensified form: and, as I have before said, that detector was simply put out as an experimental device; it was not of the present commercial form.

I do not know what I am expected to say on the general subject. There has been, as you know, a very earnest effort toward the development of some kind of a metering device which will, as far as practicable, meet the requirements of the underwriter and of the water-works man. The requirements are very, very severe. The underwriters on the one hand say that you must not put

* Mechanical Engineer, Hersey Manufacturing Company, Boston.

anything on the main fire line which will in any degree obstruct or endanger the flow. They take the stand of absolutely prohibiting, that is, so far as lies in their power,— and the power of raising insurance rates is something tremendous, — anything in the shape of a positive meter, either piston or rotary. The current meter is to-day — well, we will say tolerated — tolerated, that is, by the underwriter. The current meter being of the water-wheel type of course is less liable to obstruction, but all the commercial forms are provided with a screen, and the underwriter has holy horrors at the idea of a screen on the fire line; because in the first heavy draft incident to a fire there will pass from the mains large accumulations of sediment, scale, grass, and all kinds of things which are, but which ought not to be, found in good water supplies.

So, therefore, in the attempt to work out this problem we went to the underwriters, and we said, "What will you allow? We have got to have something on that pipe in order to approximate some kind of measurement, in order to undertake to do anything in the way of measuring water." After it was all boiled down it seemed that about the only thing that would be permissible would be a self-acting swing check-valve, just such as Mr. French uses in his meter and just such as is used in the Hersey Detector Meter. Now, with only that on the fire line the question of obstruction seems to be settled, that is, so far as the underwriters are concerned.

Then comes the other side of it — what does the water-works man want? He wants to measure all flows down to a gallon or two a minute, and everything over that clear up to the highest rate. Bearing in mind the fact that fire supplies are generally and should always be — so our underwriting friends tell us and so our water-works friends agree — used for fire protection only; bearing in mind that water if used at all for other purposes on those lines is used illegitimately, and bearing in mind also the fact that all men are not thieves, that there are not 10 per cent. of them who are, — not one per cent. we hope, — there is a very small percentage who do, we are forced to admit, deliberately take water. Thus, there is a very large percentage of fire services which, if supplied with something in the shape of a detecting

device, would seem to meet the requirements of the water-works man. Hence the development of the detector meter, which is a device which will measure all flows, from 1 up to 150 gallons a minute, and which, when there is a call for a sudden draft for fire or other emergency, will open wide and give unrestricted flow.

Now Mr. French and his associates, with infinite patience and skill, have gone still further than we have. Our device and the device of which Mr. French has spoken are parallel up to a certain point. Both have the weighted differential check-valve, and both have the by-pass meter; but in the latter device they go further than we do. While we measure simply the water passing through the by-pass, they measure all the water. If as a matter of record it is desired to parallel the description of the French device with a description of ours, I will, if you please, submit Mr. French's report on the Hersey Detector Meter, as prepared by him as chairman of the Private Fire Service Committee of the National Fire Protection Association, and which he presented to the association, and which is printed in the 1905 transactions, as a part of my remarks, giving as it does a description in Mr. French's own language of the Hersey Detector Meter.

This device is called the "Hersey Detector Meter." Its object is to measure accurately drafts up to about one hundred and fifty gallons per minute, and to detect and exhibit the flow of any additional quantity in excess of the above amount.

The device consists of an indicating check-valve in the fire-service main and a meter on a by-pass around it. There is no mechanism in the main pipe except the check-valve, which offers no objectionable resistance, and gives a practically unrestricted waterway for use in case of fire.

What the detector does, is, first to cause all drafts up to about one hundred an dfifty gallons per minute to go around through the by-pass meter, where they are all measured; second, to give a positive indication that while this is going on the check is closed; third, to give a positive indication if the draft exceeds 150 gallons per minute, and about how many hours such an excess has been going on and, if desired, to indicate about when it took place.

The device is furnished completely assembled so that it may be set as one piece in the main pipe line. It may be assembled so that the by-pass will be on either side of the main fire line, or on top or underneath if more convenient. The by-pass is controlled by valves so as to permit inspection of the meter without

closing the fire line. In case it is desired to use the whole device in place of the main yard check, the valve on the mill side can be a check-valve.

The main check-valve is provided with a differential seat which, with the by-pass, gives an initial resistance of about 6 per cent. of the available pressure. When the by-pass meter is delivering about one hundred and fifty gallons per minute, the friction loss through the meter reduces the back pressure on the check to the equalizing point, and any draft in excess of 150 gallons per minute unseats the check and finds unrestricted passage through it.

The moment the check leaves its seat a small amount of water flows from the differential seat to the atmosphere through the small indicating meter, and this meter will continue to run as long as the check is off the seat.

The check is so weighted that it will close when the flow drops somewhat below the flow which caused it to open.

The device will, therefore, accurately measure all leaks or ordinary small drafts, will give unrestricted water-way for use in case of fire, and will detect and show if water has been used in very large quantities, giving an approximate idea of the length of such use, and of about when such drafts occurred.

Mr. French. Mr. President, if I may take one more minute I want first to pay my compliments to Mr. Kimball. Mr. Kimball has been possibly one of the great spurs to our activity in this matter, because he desired to measure every bit of water down to a single drop, and when he stood at Lowell last Saturday and looked down on that meter and said that he felt that it would really do the work, it was the top notch of commendation. Nothing more can be said.

Now, there is one thing which would be of a good deal of interest to us. I should say, looking at it broadly and putting aside our own pride, which in the insurance business we generally put one side, that we should like very much to know the general feeling of water-works men as to the need of a meter to measure all flows. This meter of ours might in a way be designated as the "all-flow meter," or some such thing as that, — we are trying to think of a good name for it, — and our feeling is this: that a simple "detector device" would be from our standpoint, perhaps, less objectionable on the fire service than this which has something more to it. That is, we don't want anything, and the less we

have of something the better we will like it. That is putting aside our own development, which, of course, in a way we are quite proud of. And I should like to know whether in the judgment of water-works men a simple detector device which would measure all flows up to say 150 gallons a minute, and which after that would merely indicate that there had been large flows, doing simply what the Hersey Detector does — whether that would not in a great many cases be all that was necessary. And if it would be all that is necessary it certainly is the simplest thing. We have discussed that among ourselves, and we simply stuck to our goal. We started in with the idea of making a meter which would measure everything, and we thought we wouldn't stop until we got there; but that does not mean that in practical use something even less extensive might not be just as good and, being simpler, perhaps better. It would be quite interesting to us to know the general feeling on that line.

MR. GEORGE A. STACY.* We haven't as yet had any of these troubles in Marlboro. Of course we are interested in this matter, however, for we don't know how soon it may be up to us. All of our factories have sprinkler systems, and some of them have three and some have four connections, and I can say that up to the present time we do not know of a single instance where any water has been stolen from us. There has been only one instance during an experience of twenty-two or twenty-three years when we have had any suspicion that water was being stolen.

THE PRESIDENT. We should like to hear from Mr. Nash.

MR. LEWIS H. NASH.† I do not feel that I can add anything to the discussion, for the reason that I came into this matter a little late. I think some of our friends had been working on this problem a year or two before it presented itself to me as one which needed attention. Some years ago, however, I made some experiments in proportional meters, and during that time I went over ground very similar to this. In fact I made use of a great number of different methods of obtaining proportional measures, and in one of those devices a weighted valve was used, which weighted valve was governed by the flow of the water, and the

* Superintendent of Water Works, Marlboro, Mass.
† Mechanical Engineer, National Meter Company.

device was expected to register upon a drum so as to give the amount of water in proportion to the opening of the valve. That was a good many years ago and the thing was laid on the shelf then because at that time I did not think it was a device which was needed. But there was enough done by me at that time to make me certain that something in this line will be successful, and as I listened to Mr. French's paper it seemed to me that he has come to the best solution which has been brought forward, so far as I know.

Of course the success of the device will depend very largely upon how the mechanism is constructed and how durable it would be, and upon points like that, which nothing but experience can determine. As I understand the problem, the intention of the insurance people was first to stimulate the thought of those who are manufacturing meters, to see if something could not be produced which would be satisfactory to them, and they having failed in the first place to exhibit that interest, the insurance people have taken up the problem themselves, and I think they are to be congratulated upon their success, so far as it has been shown here to-day. I suppose perhaps some of us meter people will now "get a move on."

MR. ROBERT J. THOMAS.* Mr. President, it seems to me that both the detector and the meter which Mr. French has described will have their place in the metering of fire services. In a great many cases the detector will answer the purpose perfectly, and in other cases it will be necessary to have all the water supplied through a fire service metered. This matter of metering fire services has been agitated, as you know, for two or three years, and was referred to a committee, of which I am a member, and we have made two or three reports. To-day, owing to the absence of Mr. Crandall, the chairman of the committee, we haven't any written report to make. The work of the committee has been fruitful; there is no question about that. The results are known to those of the members who have kept in touch with this matter. I think the paper of Mr. French is an indication of the good work that was started by this Association and carried along to a great extent by your committee. The paper read by Mr. Sullivan last

* Superintendent of Water Works, Lowell, Mass.

March, and the paper read previously by Mr. Kimball were indirectly the result of the work of the committee. That is to say, Mr. Kimball, representing General Wheeler of the committee, made the tests at Knoxville of meters for fire services. Mr. Sullivan at Lowell, representing myself and the members of the Lowell Water Board who were interested in this matter, made the tests in Lowell in order to find out the best type of machine or device for measuring fire services.

The fact that water supplied through fire services should be metered was recognized, I suppose, by all the members. In our previous discussions of the subject in this Association there was hardly a dissenting voice as to the necessity and the importance of a water-works department knowing the amount of water which was being used by factories and power stations and various establishments which were supplied by pipes 6, 8, 10, and 12 inches in diameter. It has been well recognized that there is, to say the least, a great waste of water, a great waste of a valuable commodity, which water becomes, especially when it is pumped, through these fire services.

It appears now that Mr. French is just as ardent a supporter of metering fire services to-day as any water-works man, and for the reason that he believes it is for the interests of the insurance people to have them metered. You notice what he said about the importance of having the fire service used exclusively for fire purposes. He told you of an instance where they were using water for other than fire purposes and they were able to get only two fire streams at the time of a fire when they should have had four streams. That, of course, is a very important matter in the estimation of the insurance men, and of water-works men also, for we all agree that a fire service, intended for the extinguishment of fire, should be as complete and perfect as possible and ready whenever it is needed. The use of water for other than fire purposes interferes with the efficiency of the fire services, and it may practically destroy it at the time of the greatest need. Now, if you put a meter on the service and measure the water and make a concern which is using the water illegitimately pay for it, the chances are that they will not use it to the extent that they have been. They certainly will not use it to the extent that they

do when they get it for nothing, as they are in a great many cases from probably every water-works department in the country that is supplying large fire pipe lines.

The American Water Works Association has taken about the same position that the New England Water Works Association has on this matter, and has voted in favor of meters. The committee of the American Water Works Association has come to the same conclusion that your committee has, and there seems to be quite a unanimity of feeling that fire services should be metered, either by meters measuring all the water flowing through them, or by detectors which will detect the fact that a concern which is given the privilege of a fire service is abusing it, and then the city department or the water company can reckon with them and make them pay for the water used, or else make arrangements so that it will be impossible for the water to be used in the future.

Another matter with regard to fire services. It is well understood, of course, that the city is willing at all times (and the private water companies, too), to go to quite an expense to put pipe into the different mill yards, and not only into mill yards, for we have breweries supplied with fire services as well as cotton mills and woolen mills and wood-working establishments. All kinds of property are supplied with fire services, so this is not intended to apply to any particular industry; they all need water, and you will find that they all use it, particularly if they can without paying for it. Now, as I say, the city is at all times ready to furnish a supply of water for the purpose of extinguishing fires; but at the same time the laying of large mains into private concerns is a privilege they are getting from the city, and that privilege should not be abused.

Now, if there is some safeguard, such as the meter Mr. French has told us about, or the Hersey Detector, or some other device, why should it not be put upon the fire services to prevent their abuse, and to give the water department the knowledge which they have in every other case? As a rule now the custom is not to supply water to a private dwelling without a meter, and if we are so careful in regard to supplying private houses, tenement property, etc., with water, to know where the water goes and to put a meter on, we certainly should be just as careful to ascertain what

becomes of the water and how much of it is used, which goes through a 6-, 8-, 10-, or 12-inch pipe. The size of the main should not be an argument against putting on a meter.

We have a large concern in Lowell which had three fire services put into their premises, two 8-inch and one 6-inch, and they had probably thousands of feet of pipe laid through their yard. They wanted another service put in; the water board told them that in order to have that other fire service they would have to have all their services metered. They looked up the price of meters and found it would cost about two thousand dollars, and the agent of the concern said, "That is quite a bill for us to pay, and quite a hardship." I thought so myself, and so did the board, but they had to begin somewhere and here was an opportunity, and they said, "You shall not have this extra supply of water unless you meter the others."

They were insured with the Factory Mutuals; and by the way, the Factory Mutuals, as we all understand, are one of the greatest insurance organizations in this country, and when a representative of that company advocates meters it means a good deal. They consulted the Factory Mutuals, and in a short time I heard from Mr. French. He said, "The Lowell Bleachery telephoned to me with regard to having some meters put on." I told him the exact condition of affairs and he said he would recommend that the concern discontinue one of the services and meter the two 8-inch services, and also that the new service, which was to supply a cistern, should be metered. And the company, I am pleased to say, shortly afterwards made an application for the meters, one on the new service, and two 8-inch detector meters. We have metered quite a number within the last couple of weeks and expect to continue the work. It seems now if any water-works superintendent thinks his city or company is being robbed, or that there is a great waste of water — I won't say they all steal the water, for we find in a number of cases the owners of the property don't know that the water is being used, but some subordinate finds it to his advantage to use it and uses it without consulting the owner — there is nothing to hinder him from putting on a meter. The owner of the concern cannot go back to the old argument that the insurance company won't allow it.

MR. FRENCH. I should like to make it very clear that the two meters which were put on in Lowell were the detector type of meters. That was the one restriction we made, and it was a restriction which Mr. Thomas and the water board were very willing to agree to. Mr. Thomas stated that, but I should like to make it a little clearer. We really haven't quite come to the position yet where we are advocating putting meters on every fire service, although we have come a long way, perhaps, from where we used to be. I think our feeling is this: that certainly our own device, and I think I may say the Hersey device, which happens to be the only one now available, both yet lack long experience. My own feeling is that there are a good many small and simple fire services which can be trusted to-day, and that it would be prudent and reasonable on the part of all of us not to insist on metering right away everything that we can see. We will not object to metering fire services in places where it seems necessary with some devices of this kind, but we should like to have the work go on slowly enough so that we might find out any little difficulties which experience almost always develops in the working of even the best thought-out device. We should like to get a little of that experience before we have a very large number of them in use. Of course in a year we will get a good deal of experience. I mention this for the reason that I believe that there are a great many small plants and some larger ones having new equipments that are perfectly simple, where perhaps it is not necessary to clap on a meter immediately. I think it would perhaps be only reasonably conservative to take the few worst places in any district until we get a bit of experience, and then we may perhaps hereafter be willing to go as much further as is necessary.

MR. BEMIS. Where cities are putting meters on at the expense of the department but haven't metered the fire services, I suppose Mr. French has no objection to our requiring the consumer, in the case of fire services at least, to pay for a detector meter or for his meter?

MR. FRENCH. We really do not care who pays for it. That is purely a question of practice in the city. Some cities buy the meters, I believe, and others make the consumer pay for them. It is quite immaterial, of course, from our standpoint.

MR. F. A. W. DAVIS.* Mr. President, I am heartily in favor of any device which will prevent water being used surreptitiously in a factory; but there is one feature of this whole subject which should not be overlooked by the water departments. The requirements of the insurance companies are for larger mains, increasing the size constantly. Now, can the departments afford to do that? I do not mean in the way of furnishing a water supply, but can they afford to jeopardize the balance of their systems and their obligations to the public at large? And when they put a main into a factory, which in the event of a fire may be broken and destroy the pressure in the neighborhood, that should be considered in talking about furnishing inside fire protection. Mr. Kimball has had some experience on that line, and I have known a number of cases where the pressure has been so reduced by a broken pipe as to make the department almost helpless.

MR. FRENCH. Mr. Davis has struck on a very vital point for the water department and for the protected risk, and I want to mention one or two things which in a way are on the other side. First, I should like to say this: That I believe that any fire protection engineer who is true to his calling will never put a pipe into a building the breaking of which would cripple the fire service. It is one of the cardinal principles of fire protection engineering that every large pipe going into a building shall have a properly located outside shut-off. In our own work, where we are dealing largely and almost entirely with mill yards, we usually provide a gate in the yard with an indicator post standing up above the snow line and very accessible. We have done that for years for our own protection. In the early days we had several mills burn, and the breaking of the pipe destroyed the protection of the rest of the yard. Those were mills in the country and they were dependent on their own supply for protection. But it is just as necessary to avoid that danger in the city as it is in the country, and we invariably put not only a gate on the service from the city, but a gate on every connection going into every building, and we locate that gate outside of the building in such a position that we believe it will always be accessible even if the building which the supply protects is on fire.

* President, Indianapolis Water Company, Indianapolis, Ind.

The next point is this: That in a city (I think a careful study of the records will prove this absolutely) the risk that is sprinklered is the one which is least likely to cause a bad fire, or to cause the start of a bad fire. At Baltimore I have no hesitation in saying that had the risk in which the fire started been sprinklered the Baltimore conflagration would not have occurred. As it was, the fire came up to two large sprinklered buildings, which were insured in some of the mutual companies, and the sprinklers in those buildings stopped the fire, so that those buildings marked the boundary line of the fire in their direction. At Toronto the same thing occurred. The fire came up to one building and got into it. The water supply was pretty good but it was not sufficient to check the effect of the terrific heat, and the roof was burned off; but the operation of the sprinklers introduced the element of delay at that point which enabled the fire department to check the fire there. So it seems to be true that while the private fire service does put a large pipe into a building, it at the same time immensely reduces the chance of a fire in that building assuming dangerous proportions; and, furthermore, it makes the building a strong barrier against even a conflagration which is coming toward it.

Looking at the thing broadly, and understanding that the water-works man feels it is his duty to prevent fires, there is no better way of doing this than by equipping buildings with automatic sprinklers, and to be serviceable they must have a large water supply at a reasonably good pressure. So we must remembe· that while we possibly introduce a danger when we sprinkle a building and carry a large pipe into it, we on the other hand very much reduce the chance of a bad fire. And I think there can be little doubt in the minds of those who study the action of sprinklers, that if all the buildings in a city were sprinklered the conflagration hazard would be absolutely eliminated. That is the position practically of underwriters of all kinds whether of stock or mutual companies.

There is yet another point to be considered here. I suspect that in many cases the connections which have broken and made trouble have been elevator connections or something of that kind, and I think it is quite as necessary for the water-works

engineer to give careful attention to all of his large services as it is to single out those intended solely for fire protection.

MR. MORRIS R. SHERRERD.* What Mr. French has just said may perhaps be true from the point of view of the Factory Mutuals, but I want to add a word in support of the position Mr. Davis has taken. I find that many of the insurance people are very unreasonable about the size of the fire connection they request the property-owners to provide. Invariably they want it as large as the size of the main in the street, up to twelve inches. If there is a twelve-inch main in the street they will ask the proprietor of a large department store, for instance, to install a twelve-inch pipe. We have adopted a rule in Newark to lay from our high-pressure fire system nothing larger than six-inch connections. If the owner of a large building wants to put in a sprinkler system, and the insurance people require a greater supply than a six-inch, we will allow another six-inch connection which shall be located in a different part of the building, so that in case a fire gets beyond control, a falling wall would not be likely to break both connections and thereby seriously affect the general protection. Of course I can appreciate that it is of advantage to the city to have these large buildings properly protected by sprinklers, but some of the representatives of the insurance companies, I am sorry to say, impress me as only considering the particular risk upon which they are working, and arbitrarily demand as large a connection, even from high-pressure lines, as was formerly requested from the regular service.

MR. W. C. HAWLEY.† Answering the inquiry which Mr. French made regarding the matter of preference between these two devices which are before us, personally I cannot see very much to be gained by a device which measures all flows of water unless in cases where water which may be used in a fire is paid for on the basis of the quantity used. The other device measures what is wasted or what is stolen, and it seems to me that that is the important thing for us to know.

The report of the committee this morning regarding the method of charging for metered water, and the point that we have reached

* Chief Engineer, Water Department, Newark, N. J.
† General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa

in this discussion, brings a matter to the attention of this Association which should be taken up, and that is the proper basis on which to estimate the value of fire protection to manufacturing or other concerns that have special protection. At present there are various ways of measuring it. Sometimes it is to count the number of hydrants and the number of sprinkler heads and charge so much for each; sometimes it is simply a flat rate, without any particular method of getting at it. If we could get as satisfactory a solution of it as has been presented by the committee of the problem of meter rates, it would be an excellent thing for all who have this subject confronting them. I would move, therefore, that a committee of five be appointed to consider this matter and report at some future meeting of the Association.

MR. SHERMAN. If I am not laboring under a misapprehension, Mr. President, that very subject is among those referred to our present committee on fire services, which was scheduled to report to-day, but which, as Mr. Thomas has told us, will be unable to report on account of the absence of the chairman, Mr. Crandall.

MR. T. H. MCKENZIE. I certainly approve of Mr. Hawley's motion. It seems to me the old committee is rather avoiding the main question of recommending rates for fire services. They get off on to other subjects and do not quite come to the point of recommending rates for sprinklers and hydrants and other methods of fire protection.

MR. HAWLEY. When I brought up this matter I did not know that it was being considered by any committee. If that is the case I will withdraw my motion, but I certainly think this is a matter which should be given attention, and that the Association in the discussion of this general subject has now reached a point where this specific matter should be taken up. I will make the motion that the committee consider and report a method or methods by which the value of fire protection can be estimated.

MR. HUGH MCLEAN.* In our city we find them coming out into the mill yards and putting their fire hose on to the hydrants. In New England cities like Holyoke, and other cities where they use water for power a great deal of the time, when the water-power plant is shut down they find it convenient to attach the hose to

* Member Water Board, Holyoke, Mass.

the city supply to get water to wash up with, and there is a great deal of water used in that way. We have been trying hard to get at some method of putting a meter on the fire service so as to stop that. Our ordinary consumption is from 70 to 75 gallons per capita between the hours of one and five in the morning. We sent men to go through the mills, and the owners put them out or wouldn't let them go through. Then we got an opinion from the city solicitor which forced them to allow the inspectors to go through. I want to say in behalf of the manufacturers that I do not think they themselves are responsible. We have had letters of apology from the leading mill superintendents. But it is certainly very convenient for the employees to use the water. I know when I was a boy and worked in a paper mill it used to be very convenient for me to get hold of a hose and wash down the screens and the wires and do the general cleaning up, and it is a habit now, and we want to find out some way of stopping it. Applying a meter on all fire-service connections in mills will do it. So if it is possible for this Association to go on record in favor of a meter which can be immediately applied, we would like to take advantage of it.

Mr. Hawley's motion was adopted.

MR. STACY. I consider this last question which has been before us, and which, as I understand, has been referred to the committee, a very vital one. It is something which has been before the Association for quite a while. I do not know of anything that this Association has ever taken up that it has not carried through, as is illustrated by the matter of the metering of fire services which our committee has very efficiently forced to an issue, in one sense of the word. And now I would move that, in order to strengthen the committee still further, Mr. Batchelder of Worcester, water commissioner, be added to it, for he is a man who has had a good deal of experience along this line.

THE PRESIDENT. That would make a committee of four; shouldn't there be five?

MR. STACY. I would suggest that Mr. McLean of Holyoke also be added.

It was voted that Mr. George W. Batchelder and Mr. Hugh McLean be added to the committee.

REPORT OF THE COMMITTEE ON METER RATES.

FREEMAN C. COFFIN, CALEB MILLS SAVILLE, HENRY V. MACKSEY, FRANK E. MERRILL, CHARLES F. KNOWLTON, *Committee.*

[*Report presented September 13, 1905.*]

To the New England Water Works Association:

There are indications that a point has now been reached in the history of water meters from which there will be a greatly accelerated increase in their use. The fact is undoubtedly established in the minds of water-works men that the general use of meters prevents most, if not all, of the waste of water in the houses of consumers, and that it does not restrict a liberal use of water for all legitimate purposes. There is still, however, an honest disinclination to adopt meters, arising largely, it seems, from the fact that so little can be predicted of the effect of their general use upon revenue, and from the difficulty of devising rates that will be just and fair to all classes of consumers.

There is, of course, the ignorant opposition based upon the belief that meters will make water scarce and high, and the opposition that seeks political advantage by the false cry of a free and abundant supply of water, neglecting the fact that in few, if any, works is there any charge whatever for water itself, but only for bringing it to the consumer at less expenditure of time and money than he could bring it from a pump in his yard, if the well and pump were furnished to him without cost.

There is still a strong disinclination to adopt a meter system rather than provide at much larger cost a new supply or additional piping or pumps when the available supply is getting short. This is largely due, however, to a natural preference for a "sure thing." As further experience shows that the use of meters is certain to reduce a large per capita consumption of water, and furnishes us with absolute data from which to estimate what it will do in this respect, this obstacle to their adoption will disappear.

If, then, methods of fixing meter rates were available by which the problems and difficulties now attending the change from fixture rates to meter rates could be eliminated or greatly lessened, the general use of meters would make rapid progress.

Your committee believes that its proper work lies in this direction: namely, of suggesting, if possible, some method or methods for fixing rates that will avoid some of the difficulties now apparently inherent in the change to meters, and which those works already having a partially metered system will find more satisfactory for an entirely metered system than the rates now in use.

The committee does not believe that it is desirable to attempt to fix a scale of prices. In its opinion this would be most impracticable, and no such scale could be devised that would meet with general adoption. It is desirable, however, to establish some basis upon which a scale of prices can be devised for any particular system, giving consideration to the conditions prevailing in such system.

Desiring to do its work with as full knowledge of present practice and its results as possible, the committee sent blanks asking for information and statistics relating to the meter system in the works under their charge to the members of the Association, and received seventy-two replies. This information has been tabulated as far as seemed desirable, and this tabulation and a general summary of some of the results are appended to this report.

The committee then took up the question and tried to ascertain just the problem that was before it, and gives the following as its conception of it.

THE PROBLEM.

The problem is to devise a method or methods by which meter rates can be arranged that will most nearly meet the following requirements, and do so with substantial justice to all classes of consumers and the greatest possible simplicity of operation.

REQUIREMENTS.

First, to insure a sufficient revenue to meet the demands of the system, whether it be a municipal system, operated practi-

cally at cost, or a system owned by a private company upon which a reasonable profit must be secured.

If a sum is raised by taxation for fire protection (as there always should be if justice is to be done between consumer and taxpayer), that sum must, of course, be deducted from the amount of the total maintenance to find the amount necessary to be raised by meter rates.

Second, the method should be sufficiently flexible so that the rates may be easily changed in case of a deficiency or surplus of income.

Third, the method should allow of the use of meters upon services with a single faucet without increase over the faucet rate, unless for actual use or waste of water. It should also secure from large, well-plumbed places a reasonable amount to meet fixed charges, even if little water is used.

Fourth, the method should meet the conditions of places with a fluctuating population and a large seasonal use of water, such as summer and winter resorts.

Fifth, the method should be such that it can be adapted to the different conditions of works in which the fixed charges are high and the operating expenses low, as in gravity systems, and where perhaps a large use of water at a low price is desirable; or where, on the other hand, the fixed charges are lower in comparison with the operating expenses, as in a pumping or filtering plant, and where it is desirable for any reason to be prudent in the use of water, and where large use at low rates cannot be encouraged. The method should be one that will meet the requirements of a "flat rate," with no discrimination between users of water, and still permit the supplying of large users such as factories at a cost that will not be prohibitive in cases where it is desirable to encourage such use.

SUGGESTIONS.

In view of the foregoing and as the result of its study of the subject, the committee suggests the two following methods of assessing rates for supplying water through meters:

First, the assessment method.

This is considered by the committee as the most scientific method, and one adapted for general and permanent use.

Second, the multiple minimum rate method.

This method, which is called the "multiple minimum rate" method to distinguish it from the single minimum method now largely in use, while not considered by the committee as so suitable for all conditions as the first, or "assessment method," is well adapted to securing a revenue similar to that obtained by fixture rates in works where the change is being made from fixture to meter rates, and where there are no data relating to the probable consumption with meters. In new works also it may be possible to estimate more closely the probable revenue to be received than with the first method. The following discussion will treat the two methods more in detail.

THE ASSESSMENT METHOD.

By this method the rates will be assessed as follows: A constant sum will be assessed each year upon each property based upon the frontage of the lot on one street, and without regard to the amount of water used. In addition to this assessment, a certain price per 100 cubic feet or 1 000 gallons will be charged for all water used through the meter.

FRONTAGE ASSESSMENT.

There are certain expenses of a water-works system which must be met as long as the works are operated, which are affected but little, if at all, by the amount of water used. These expenses should be met by a revenue which is also independent of the amount of water used. The total amount of such expense is dependent more upon the length of the piping system than upon any other element of the plant. The amount of water used affects the capacity of the pumping plant, but not in direct proportion, and in many works not at all. The requirement for fire protection fixes the pumping capacity. The amount used affects the capacity of the supply, but not necessarily its distance from the center of distribution.

The frontage of the lot affects materially the total length of the piping system. Therefore there seems no other element

which can serve so well and so justly as the measure of the constant yearly assessment as the length of frontage of the property. It is not material to the method how the frontage which shall be assessed is determined. It is probable that a municipality can assess all property, both that built upon, and vacant lots, while a company can only assess upon existing houses and their lots. It would seem to be fair that all buildings should be assessed, whether occupied or not. This, however, is not essential to the method. If vacant lots were not assessed, some limit to the amount of land to be assessed with each building would be necessary; for instance, each lot might be assessed upon a length not exceeding twice or three times the width facing the street, of the building upon it. A corner lot might be assessed upon one street only, or, as in the case of sewers, a certain frontage of the second street might be exempt. These details are not essential to the principle, and should be decided by the conditions of each case.

The exact proportion of the total annual expense of maintenance which should be assessed in this way is not essential. It seems to the committee, however, that it would be substantially just if, in ordinary cases, one half of the total amount to be raised were assessed upon frontage and the balance raised by meter rates based upon the total consumption. The price per 100 cubic feet, or 1 000 gallons, in any place would then depend upon the total consumption. Taking the average place, it might be about 7½ cents per 100 cubic feet, or 10 cents per 1 000 gallons, based upon the water that would be measured through the meters.

The above is a brief description of the method. It must be examined to see how it will meet the requirements.

First, to insure a sufficient revenue.

In new works, or in those which are changing from a basis of fixture rates to meter rates, there are very few data upon which to estimate the probable consumption of water after meters are installed, or rather the amount of water that will be measured through the meters. It cannot be estimated with precision how much the use of meters will curtail the total amount pumped or drawn from the source, and of the total amount the quantity measured depends upon the leakage in the piping system, the

slip of the pumps, etc. In many cases of gravity supplies, there is no knowledge of the quantity of water drawn.

This method of assessing one half or a fixed proportion of the total annual expense upon frontage assures that a certain sum will be secured, and thus reduces the percentage of error by making the sum that is based upon the probable consumption much smaller. After one or two years' experience with meters, the amount passing through them can be closely approximated and a rate established that will secure the amount required with as much accuracy as necessary. There is no system possible under which the exact revenue can be established, and this is not necessary.

Second, flexibility.

While it is not desirable to change water rates frequently, it sometimes happens that the conditions permit of their being reduced, and it is conceivable that under some circumstances they must be increased. As compared with fixture rates, or even with meter rates, based upon a minimum charge, this method offers a very simple way of changing the rates, and the approximate results of the changes can be closely estimated.

In case of a reduction. If it is considered desirable to have the price of water low, and encourage its use, the assessment can be maintained as it is and all of the change made in the rates, when the preceding year's record of consumption of water through meters will furnish a basis upon which to estimate the rate necessary to secure the desired reduced revenue.

On the other hand, if the supply is rather limited, or the cost of securing and delivering the water is considerable, and it is desirable to conserve the water, the assessment can be reduced and the rate maintained. It is probable that the law of demand and supply would be operative with water as with any other commodity, and a high price for water would tend toward a prudent use, and a low price toward a lavish use.

Third, satisfactory use of meters in all classes of services.

It is believed that this method will allow the use of meters on services with only a single faucet, and also in large houses in which little water is used, with substantial justice and with satisfactory results in revenue to the department. Aside from occa-

sional exceptions, houses with a single faucet are small and on narrow lots, while large, well-plumbed houses generally have greater frontage. These different classes of property would bear their proportion of fixed charge in a fairly equitable manner. As long as each pays its fair proportion of fixed charges, there is no reason why a single faucet using large quantities of water should not pay for it, and on the other hand, why a large, fully-plumbed house should pay for water which it does not use.

Fourth, for summer and winter resorts.

This method seems very well adapted to the conditions in places where there is a great fluctuation in the use of water. Those consumers who actually use water for only a few months in the year must pay the fixed charges for the entire year through the assessments, and if they use a very large quantity of water during their short stay, pay for that at meter rates.

While places of this sort need metering as a means of water-waste prevention more than many other places, it is very difficult to meter them under the methods of fixture rates now in use. The transient consumers, while using large quantities of water for a short time, do not use enough in the whole year to exceed the ordinary minimum rate, and thus, while making it exceedingly difficult and costly to supply them while in town, do not do their share (under ordinary meter rates) toward supporting the works, the fixed charges of which are tremendously increased by their requirements.

This class of consumers would be reached through the frontage assessment, and in such places the portion of the entire annual cost which was assessed upon frontage could be larger than in places with more normal conditions.

Fifth, adaptability to differing conditions.

It is evident that a gravity system with a large sum invested in the plant and very small operating expenses is furnishing water under entirely different conditions than obtain in a pumping system in which the plant is of much less first cost but with large expenses for pumping.

If the first system has an ample supply, it costs no more (within certain limits) to furnish a large amount of water than a small one. With regard to the furnishing of water, almost

all of the expenses are in the nature of fixed charges, and the net revenue of the works is directly increased by the sale of additional water at almost any price. In such a case it is, no doubt, good policy to encourage legitimate use of water in large quantities in a way that could not be done under a " flat rate " if the entire annual expenses were raised by meter rates of so much per one hundred cubic feet. With such rates, nothing but a sliding scale of prices would accomplish the result.

In such a case as stated above, the proposed method provides a way to adopt a " flat rate," and also to encourage the use of water in large quantities without discrimination. By assessing a very large proportion of the annual cost upon frontage, and raising a small proportion by meter rates, the price can be made very low and the same to all consumers. In such a system it is certainly just to assess a large proportion upon frontage, for as already shown, its expenses are largely composed of fixed charges, which, on account of their nature and origin, it is equitable to assess upon frontage.

On the other hand, this method can be as well adapted to a pumping system with a comparatively low first cost and high operating charges by assessing a small proportion of the annual cost upon frontage and raising a larger proportion by meter rates. This would also be equitable, as in such a system the operating expenses would be largely affected by the consumption.

Below are a few examples of how rates might be fixed under this method in places with differing conditions. In these places, the names of which are not given, actual figures from the reports of a certain year are used.

The first is a pumping system with about 29 000 population. The works cost practically $1 600 000, with 105 miles of pipe. Annual expense, including interest and sinking fund, $106 000. Consumption, 464 000 000 gallons.

Frontage. In determining the length of frontage to be assessed, it is a simple matter to measure the lots, much easier in fact than to go through the house for a list of fixtures, as must be done under fixture rates.

In this estimate it is assumed that on each side of the pipe line the length of assessable frontage will be one half of the total

length of pipe, after excluding pipe not in streets, the length of street crossings, that passing vacant and unassessable lots, etc. Then on both sides of the pipe line there will be the same length of frontage as there is length of pipe; in this case 105 miles, or 554 000 feet of frontage. There was an appropriation of $18 000 from the tax levy, leaving a net amount to be raised of $88 000. Assuming that one half, or $44 000, will be assessed on 554 000 feet of frontage, will make an assessment of practically 8 cents per front foot. The remainder of the expense, or $44 000, is to be raised by meter rates. The consumption was 464 000 000 gallons per year, of which it is probable that about 65 per cent. would go through the meters, or about 300 000 000 gallons, making about 14.6 cents per 1 000 gallons, or about 11 cents per 100 cubic feet. It should be noted that the consumption per capita in this place was low, about 50 gallons daily, and the cost of water based upon total pumpage and total expense high, or about 23 cents per 1 000 gallons; the meter rates were high, 35 cents per 1 000 gallons. The minimum rate for meter was $10, and the amount of water allowed under this minimum about 28 700 gallons per annum, or about 80 gallons per day.

Assuming a fully plumbed house on an 80-foot front lot, using the above amount of water, the charge would be as follows:

Assessment, 80 feet @ 8 cents	$6 40
28 700 gallons @ 14.6 cents	4 20
	$10 60

If double the amount of water, total $14.80.

Or, assume a small house with one faucet on a 40-foot lot:

Assessment, 40 feet @ 8 cents	$3 20
An amount of water equal at 35 cents per 1 000 gallons to $5, or single faucet rate; or 14 350 gallons per year @ 14.6 cents	2 10
	$5 30

Take a smaller pumping system in which the per capita consumption was about 60 gallons, and the cost of water based upon the total pumpage 8.5 cents per 1 000 gallons. Total cost of works, $80 000; 8 miles of pipe.

Total annual expenditure	$6 500 00
Appropriation	1 500 00

Total pumpage of water, 76 400 000 gallons yearly. Assume the same proportion of frontage as before, 8 miles, or 42 300 feet. Net amount to be raised, $6 500 — $1 500 = $5 000. One half on frontage, 2 500 ÷ 42 300 feet = about 6 cents per front foot. Assume that 65 per cent. of pumpage could be measured, or 76 400 000 × .65 = about 50 000 000 gallons. Dividing one half of the expense, or $2 500 by this, gives a meter rate of about 5 cents per 1 000 gallons.

Assume house as before with 80-foot lot:

Assessment, 80 feet @ 6 cents	$4 80
Assume that this is an average service in use of water. The average use per service was 50 000 000 gallons divided by the number of services, 343, making 145 000 per year at 5 cents	7 25
For house using average amount of water	$12 05

Small house using one faucet and 50 000 gallons:

Frontage, 40 feet @ 6 cents	$2 40
50 000 gallons @ 5 cents	2 50
	$4 90

If this house had 80 feet of assessable frontage, its bill would be $7.30. If it used only 30 000 gallons of water per year, its bill would be $3.90.

Take a gravity system in which the per capita consumption was about 80 gallons and the total consumption was 427 000 000 gallons, and the cost of water based on total consumption 8.8 cents per 1 000 gallons. Total cost of works, $555 000; 42 miles of pipe. Total annual expenditure, $37 500; appropriation, $8 700; amount to be raised from consumers, $28 800.

If one half of this sum is assessed on frontage, assuming amount of frontage as before, the assessment per foot will be 6.5 cents. Assuming 65 per cent. as the proportion of the total consumption which can be measured by meter the rate would be 5 cents per 1 000 gallons.

The frontage rate was low on the above division of expense, and if it was thought desirable to reduce the water rate, the assessment could be increased to 8 cents per foot, which would reduce the water rate to about 3.6 cents per 1 000 gallons.

It must, of course, be understood that there was one assumption in all of the above cases which may or may not be approximately correct; namely, the assumption that the assessable frontage on each side of the pipe lines was equal to one half the total length of the lines, or that the total assessable frontage was equal to the length of the lines. The facts in any particular case would undoubtedly be different. If the assessable frontage exceeded that of the assumption, the rate of assessment per foot would be less; and if the frontage was less, the rate would be greater. This does not affect the principle and would not change the rate per 1 000 gallons for water, which would remain the same in the examples given unless the annual expenses were divided differently between frontage and rates.

THE MULTIPLE MINIMUM RATE METHOD.

This method fixes minimum rates to be paid for different kinds of fixtures in use, and a price per 100 cubic feet, or 1 000 gallons, for all water used in excess of the amount paid for by the minimum rates at the schedule price. As many or as few fixtures may be used for the basis of the minimum as is considered desirable in each case.

For simplicity in accounts, it seems better to take only a few of the important fixtures as the basis. The method also fixes what may be called a total minimum, which allows the use of water for all purposes without consideration of the number or kinds of fixtures.

As an existing example of this method, the schedule of rates for the water works of the town of Merrimac, Mass., is given below. It is proper to state that these works are only recently in operation, and the method of water rates has not been tested. All services are metered in these works.

METER RATES FOR THE MERRIMAC WATER WORKS.

All water consumers will be furnished with water through meters, and the following rates will be charged:

For 10 000 cubic feet or less annually to one customer, per 100 cubic feet, 25 cents.

For more than 10 000 and less than 20 000 cubic feet, annually per 100 cubic feet, 20 cents.

For more than 20 000 and less than 50 000 cubic feet, per 100 cubic feet, 15 cents.

No water will be turned on to any premises except upon payment of a yearly minimum charge of $6.00.

This will entitle the consumer to use water at meter rates through faucets for all purposes, except as specified below.

For use in water closets there will be an additional yearly charge of $5.00. This will entitle the consumer to use water at metered water rates through water closets and urinals of all kinds.

For use in bath tubs, an additional yearly charge of $4.00. This will entitle the consumer to the use of water at metered rates in bath tubs.

For use of water through hose, an additional yearly charge of $5.00. This will entitle the consumer to the use of water at metered rates through hose for all purposes, including sprinklers, fountains, and troughs.

The above minimum charge covers the use of water by one family or consumer at metered rates for all of the purposes for which the water is supplied by the system. No further charges will be made until the amount of water used in any quarter exceeds at meter rates the amount of the minimum charges paid for that quarter.

Any consumer paying minimum charges amounting to $20.00 per annum will be entitled to the use of water at meter rates for all purposes without regard to the fixtures in use.

The minimum charges must be paid quarterly in advance within fifteen days of date of bill.

Bills for water in excess of minimum charges will be sent out at the beginning of each quarter for the preceding quarter and must be paid as above.

The department will provide, set, and keep in repair the meters, except where they are injured by freezing, or by the neglect or carelessness of the consumer, when it will repair or replace them at the expense of the consumer. They will remain the property of the department, and the consumer shall provide and maintain a suitable place for them of easy access for reading and inspection.

It can probably be said for this method that it will meet the first requirement, namely, that of raising a certain revenue, better than the assessment method and, in fact, better than any other method yet suggested.

It will not meet the second requirement, that of flexibility, as well as the assessment method, or as well as a straight meter payment without a minimum rate.

It is exactly adapted to meet the third requirement of providing for the use of single faucets, and at the same time securing a proper return from fully-plumbed houses, and we believe will do it better than any other method.

It will meet the fourth requirement, or that for the conditions in summer and winter resorts, very well, perhaps as well as the assessment method, and much better than a single minimum.

It does not meet the fifth requirement, or that of providing for a very low rate for use of large quantities of water at a "flat rate," and no method will which does not include a definite and separate provision for an item to meet the fixed charges of the system.

In making the foregoing suggestions, the committee does not wish to seem to condemn or even to criticise any existing method of meter rates. Some are, no doubt, working to the satisfaction of the works using them, and such works being adapted to those methods might find little advantage in changing.

For works that are not satisfied with their present system, for works that contemplate changing from fixture to meter rates, and for new works, the suggestions of the committee may have value.

The committee also wishes to express its opinion on the following:

That it is desirable for the water department to purchase, own and repair the meters.

That all public buildings, watering troughs, fountains, etc., should be metered, whether or not payment is received for the water so furnished.

That all gravity works should be provided with a meter for measuring the total draft.

TABLE ACCOMPANYING REPORT OF COMMITTEE

Number.	City or Town.	How many services?	How many meters?	Percentage of metered services?	How many services have only a single faucet?	What was the total consumption last year?	What was the total quantity metered last year?	What were the total receipts for water last year?	What were the receipts for metered water?	Does the department own the meters?	Does it charge rent
1	Atlantic City, N. J.	4 636	3 943	85	....	1 433 501 560	.....	$415 778 68	$109 908 52	Yes	No
2	Attleboro, Mass.	...	1 567	100	....	170 215 160	88 051 500	29 876 22	.....	Part of them	Yes
3	Bath, Me.	2 060	105	5	856	726 233 300	.....	.....	.....	Not house meters	No
4	Beverly, Mass.	3 485	111	3	....	405 598 790	45 819 000	43 021 50	6 872 89	Yes	"
5	Billerica, "	264	142	54	72	29 151 887	.....	3 864 37	2 425 68	No	"
6	Bridgeport, Conn.	9 500	400	4	....	6 570 mil. gal.	1 000 mil. gal.	.....	Private Co.	Yes	"
7	Bristol, "	1 250	44	4	350	.....	47 364 038	.....	4 800 89	"	"
8	Brockton, Mass.	5 849	5 299	91	....	539 199 314	299 205 468	89 693 35	86 577 70	"	Yes
9	Burlington, Vt.	3 524	2 680	76	Very few	319 463 200	191 253 000	39 659 68	35 487 59	"	No
10	Claremont, N. H.	822	152	19	....	.....	.....	13 847 93	4 232 01	"	"
11	Cleveland, Ohio	60 627	30 226	49	....	22 535 360 000	8 859 446 000	776 457 62	507 525 36	"	"
12	Clinton, Mass.	1 743	1 417	82	283	211 136 055	93 321 442	29 734 73	22 262 99	Yes	Yes
13	Concord, N. H.	3 376	1 272	38	....	.....	.....	65 088 45	35 099 23	"	No
14	Dartmouth, N. S.	670	4	1	....	.....	.....	8 075 00	.....	"	Yes
15	Des Moines, Ia.	9 509	6 500	68	....	1 040 454 220	.....	.....	.....	"	"
16	Detroit, Mich.	61 465	5 847	10	....	18 757 682 350	4 973 518 572	398 290 00	136 176 40	"	No
17	E. Providence, R.I.	993	686	69	350	.....	.....	.....	.....	"	"
18	Fairhaven, Mass.	600	200	33	....	120 000 000	.....	.....	.....	No	"
19	Fitchburg, "*	4 695	2 712	58	150	1 058 500 000	.....	63 025 56	43 318 73	Owns 194	"
20	Gloucester, "	3 490	160	5	*one half	403 348 598	60 000 000	56 134 75	11 237 03	Yes	"
21	Gloversville, N. Y.	3 186	300	9	....	.....	.....	38 470 75	10 427 13	"	"
22	Greensburg, Pa.	2 424	2 656	100	....	.....	313 227 282	90 678 00	67 831 75	"	"
23	Hartford, Conn.	10 000	9 600	96	....	.....	.....	246 440 45	.....	"	"
24	Haverhill, Mass.	5 650	662	12	....	.....	.....	99 701 00	19 998 00	"	Yes
25	Holyoke, "	3 749	247	7	....	.....	470 267 250	105 053 88	24 642 34	"	"
26	Indianapolis, Ind.	14 240	900	6	....	5 713 374	.....	310 804 04	.....	"	No
27	Jacksonville, Fla.	3 270	1 706	52	....	864 301 742	.....	65 057 27	.....	All ¾"	"
28	Kewanee, Ill.	600	600	100	*10%	75 362 500	48 126 900	10 842 00	10 842 00	Yes	Yes
29	Knoxville, Tenn.	5 660	1 677	30	2 453	1 010 300 000	454 640 000	106 663 00	59 742 00	"	"
30	Leominster, Mass.	2 353	711	30	293	.....	.....	50 362 89	13 115 07	"	No
31	Manchester, N. H.	6 000	4 000	67	Very few	1 100 000 000	410 000 000	127 000 00	86 000 00	"	"
32	Marion, Ohio	891	653	73	*250	210 258 315	64 141 815	.....	.....	37%	"
33	Marlboro, Mass.	2 258	1 266	56	....	207 874 800	880 778	42 525 80	24 166 02	No	"
34	Milton, "	1 173	1 173	100	131	8 865 960 cu. ft.	8 865 960 cu. ft.	29 475 59	All water metered	Yes	"
35	Montclair, N. J.	2 650	2 650	100	Very few	350 000 000	.....	.....	.....	"	"
36	Montreal, Can.	61 395	1 108	2	....	8 970 392 604 imp. gals.	825 804 797 imp. gals.	808 479 33	159 806 46	1 031	Yes
37	Muscatine, Ia.	1 240	100	8	None	199 279 355	37 065 850	20 491 12	8 707 25	Yes	"
38	Nashua, N. H.	*4 000	657	16	....	1 118 613 656	.....	.....	.....	"	No
39	New Bedford, Mass.	9 927	1 954	19	*750	2 535 280 580	772 887 000	124 124 26	42 202 26	565	"
40	New London, Conn.	3 463	278	8	Very few	564 988 000	297 020 000	60 607 34	24 133 50	Yes	Yes
41	Newton, Mass.	7 404	6 367	86	600	769 810 000	484 000 000	128 172 00	125 278 00	About 90%	"
42	New York City	120 844	6 273	5	....	38 232 818 100	6 533 459 300	2 420 082 33	871 181 24	No	.....
43	Oberlin, Ohio	700	512	73	*150	55 600 000	21 700 000	7 657 80	6 567 80	4-5 of them	Yes
44	Paterson, N. J.	11 735	3 054	26	....	.....	87 420 700 cu. ft.	.....	97 368 08	Yes	No
45	Portland, Conn.	550	30	6	100	.....	.....	.....	.....	"	"
46	Portland, Ore.	19 473	750	4	....	.....	.....	393 446 25	.....	"	"
47	Quincy, Mass.	5 327	165	3	....	.....	.....	86 045 29	.....	No	
48	Reading, "	1 162	1 035	89	....	53 202 932	.....	10 155 12	10 155 12	Yes	"
49	Reading, Pa.	17 603	952	5	....	3 292 453 769	1 130 258 679	175 117 53	43 257 00	Yes with few exceptions	"
50	Rockville, Conn.	...	239	..	51	.....	12 000 000	.....	.....	Yes	Yes
51	Rutland, Vt.	2 462	None	0	....	2 000 000 gals. per day	.....	29 190 46	.....	"	"
52	Somerville, Mass.	11 059	1 537	14	....	2 279 637 000	416 097 066	216 027 34	60 550 61	"	No
53	Spencer, "	*800	759	95	....	.....	.....	.....	.....	.....	.....
54	Springfield, "	10 471	3 798	36	....	4 270 500 000	549 780 743	238 673 13	85 399 64	No	No
55	Stapleton, N. Y.	3 267	1 500	46	700	400 000 000	.....	.....	.....	Yes	"
56	Syracuse, "	18 988	10 063	53	....	12 254 000 daily	.....	268 088 56	188 431 68	About 500	"
57	Tarrytown, "	700	678	96	None	203 964 000	70 000 000	16 447 95	16 327 95	No	.....
58	Taunton, Mass.	4 753	2 134	45	750	554 664 539	262 995 415	64 245 76	42 017 06	"	No
59	Waterbury, Conn.	5 388	518	10	187	308 137 500 cu. ft.	58 231 714 cu. ft.	138 424 09	57 741 56	Yes	When cer amt. is n consum
60	Waterford, N. Y.	723	406	56	....	143 047 500	40 316 000 gals.	Private	62.5%	Dept. & consumers	If cons desires rent
61	Watertown, Mass.	1 7[illegible]	1 595	92	135	182 500 000	89 634 800	33 173 36	32 034 86	Yes	Yes
62	Wellesley, "	[illegible]6	911	99	340	107 202 000	55 085 961	18 352 69	14 352 69	"	No
63	Westboro, "	648	630	97	150	.....	.....	10 054 07	1 009 07	"	Yes
64	Westerly, R. I.	1 375	1 088	80	104	221 053 000	.....	24 379 18	19 176 97	Majority owned by consumers	"
65	Whitman, Mass.	1 058	5 010	47	....	50 000 000	.....	1 044 50	4 433 58	Yes	"
66	Winooski, Vt.	282	254	90	200	.....	.....	.....	.....	"	No
67	Woburn, Mass.	2 996	65	2	....	502 997 250	69 364 458	47 616 21	7 958 45	"	"
68	Woonsocket, R. I.	2 557	2 251	88	192	365 667 963	286 190 728	84 133 94	57 652 16	"	"
69	Worcester, Mass.	14 129	13 386	95	....	3 535 818 440	1 620 727 639	270 651 66	263 148 66	No, except 2" and up	"
70	Yarmouth, N. S.	1 180	6	..	475	230 249 826	6 547 475	22 507 88	1 091 89	Yes	"
71	Yonkers, N. Y.	5 675	5 804	100	....	1 743 770 000	971 883 000	.....	.....	.....	.....
72	York, Pa.	10 060	298	3	6 030	969 361 868	371 758 690	.....	.....	Yes	No

* About.

	Does it charge rent for the meters?	How much?	Does it require a deposit?	How much?	Does it place meters on services with single faucet?	Does it have a minimum charge?	How much?	What amount of water is allowed for the minimum charge?	How many metered services use less than this allowance?
	No	.....	No	.....	Gen'ly not	Yes	.....	.....	3 159
of	Yes	$2 per annum.	„	.....	Yes	„	$6 00	2 600 cu. ft.	406
se	No	.....	„	.....	No	„	20 00	8 000 „ „	65
s	„	.....	„	.....	„	.....	.....	.....	.....
	„	.....	„	.....	„	Yes	12 00	40 000 gals.	71
	„	.....	„	.....	.....	No	.....	.....	.....
	„	.....	„	.....	Yes	Yes	25 00	8 330 gals.	7 or 8
	Yes	$1 40 for ¾"	„	.....	No	„	8 00	27 000 „	.....
	No	.....	„	.....	Yes	„	6 00	4 000 cu. ft.	About 1100
	„	.....	„	.....	No	„	12 00	60 000 gals.	10
	„	.....	.....	.....	Yes	„	2 50	47 000 „	11 000
	Yes	$1 50	No	.....	No	Yes	6 00	2 400 cu. ft.	About 225
	No	.....	„	.....	„	„	2 50	1 700 cu. ft. per quarter	597
	Yes	.....	.....	.....	.....	.....	.....	.....	.....
	„	$2 00	No	.....	Sometimes	Yes	4 00	150 cu. ft. per month	775
	No	.....	„	.....	No	„	1 75 per quar.	30 000 gals.	.....
	„	.....	„	.....	Yes	„	10 00	33 333 „	400
94	„	.....	„	.....	If desired	„	10 00	33 000 „	.....
	„	.....	„	.....	No	Where city owns meters	10 00	.....	1 000
	„	.....	„	.....	„	Yes	2 00	67 000 gals.	.....
	„	.....	„	.....	.....	„	4 00	.....	Very few
	„	.....	Yes	$3 00	Yes	„	12 00	20 000 gals.	.....
	„	.....	No	.....	„	„	5 00	.....	.....
	Yes	10% on cost	„	.....	No	„	10 00	128 gals. per day	Four fifths
	„	10 to 12% of cost	„	.....	Manuf'y, elevator or municipal bldg.	No	.....	.....	.....
	No	.....	Sometimes	.....	.....	Yes	16 20	7 500 gals. per mo.	.....
	„	.....	.....	$6, $8 & $12	Sometimes	„	8 and 12	300 gals. per day	.....
	Yes	.....	No	.....	Yes	„	5 00	1 700 cu. ft. year	Close to 33⅓%
	„	From $2 to $64 yearly	„	.....	No	„	10 00	33 000 to 40 000 gals. per yr.	.....
	No	.....	„	.....	.....	„	10 00	5 000 cu. ft.	.....
	„	.....	„	.....	No	„	10 00	8 000 „	300
	„	.....	„	.....	Yes	„	2 50 quar.	10 000 gals. quarterly	About 60%
	„	.....	Yes	$12 00	„	„	6 00	1 777 cu. ft.	.....
	„	.....	No	.....	„	„	8 and 16	2 400 & 4 800 cu. ft.	.....
	„	.....	Yes	$5 00	„	„	10 00	4 445 cu. ft.	About ½
	Yes	Sec. by law	Chinese laundries only	$13 00	„	.....	.....	.....	.....
	„	10% on cost	No	.....	No	Yes	10 00	25 000 gals.	None
	No	.....	„	.....	.....	„	16 00	80 000 „	.....
	„	.....	„	.....	.....	„	5 00	33 333 „	Quite a number
	Yes	10% of cost	„	.....	If desired	„	10 00	33 333 „	Few
%	„	$1 50 for ¾" and up	„	.....	No	„	10 00	28 571 gals. and up	About 40%
	.....	.....	.....	.....	.....	.....	.....	.....	.....
em	Yes	$1 50 per year	No	.....	If desired	Yes	5 00	2 240 cu. ft.	About 100
	No	.....	From tenants only	Depends on amt. used	Yes	„	12 00	1 300 cu. ft. per quarter	About 60%
	„	.....	No	.....	No	„	15 00	60 000 gals.	None
	„	.....	„	.....	Yes, if waste is detected	„	Fixture rate	Quantity paid for by schedule rate	About ½
	.....	.....	.....	.....	If desired	„	18 per yr.	60 000 gals.	75%
	„	.....	No	.....	Yes	„	6 „	16 000 „	604
h	„	.....	„	.....	No	.....	.....	.....	.....
ns	Yes	$1 per yr. for small, 10% pr yr. for large.	„	.....	Yes	Yes	6 00	25 000 gals.	.....
	„	¾", $1 50; 1", $2; 1½", $4; 2", $6	„	.....	„	.....	.....	.....	.....
	No	.....	„	.....	Not yet	Yes	1.50 each quar.	1 250 cu. ft.	Few
	.....	.....	.....	.....	.....	.....	.....	.....	.....
	No	.....	.....	.....	.....	.....	.....	.....	.....
	„	.....	No	.....	No	Yes	2 50 pr. qr.	740 cu. ft. per quar.	About ¼%
0	„	.....	„	.....	„	„	5 00	3 600 cu. ft. per an.	5 000
	.....	.....	.....	.....	Yes	„	1 per qr.	333 cu. ft.	95
	No	.....	.....	.....	Seldom	„	10 00	40 000 gals.	900
	When certain amt. is not consumed	$2 to $30 per an.	No	.....	No	„	5 00	17 000 „	10
r	If cons'r desires to rent	10% of first cost	„	.....	If waste is found	No	.....	.....	.....
rs	Yes	$1 00	Yes	$10 an.	No	Yes	10 00	4 000 cu. ft.	656
	No	.....	No	.....	Yes	„	6 00	16 000 gals.	300
	Yes	¾", $1 50; larger, 10% of cost	Yes	$5 00	„	„	5 00	16 724 gals. per an.	225
	„	$1 per annum	.....	.....	„	„	10 00	33 333⅓ gals. per an.	767
y	„	10% of cost	No	.....	Sometimes	„	6 00	30c. per 1 000 gals.	½ perhaps
s	No	.....	.....	.....	If desired	„	2 per qr.	1 000 cu. ft.	119
	„	.....	.....	.....	.....	.....	.....	.....	.....
	„	.....	Yes	$10 ¾" size	No	Yes	10 00	33 333 gals.	893
	„	.....	No	.....	Yes	„	4 00	16 000 gals. per an.	Quite a large number.
	„	.....	.....	.....	.....	.....	.....	.....	.....
	No	.....	No	.....	Yes	Yes	1 per mo.	3 333 gals. per mo.	66

out.

DISCUSSION.

MR. CLEMENS HERSCHEL.* As the Committee on Meter Rates has especially desired that its suggestions be discussed and criticised, the following is submitted. It has been written out, so as to give the careful attention to the subject which its importance deserves.

Very slowly a reform in water rates, made possible by the invention of house meters that can be manufactured at a moderate price, and by their improvement until they have become marvels of mechanical perfection, is taking place. But discussions such as this keep up the interest, and sometimes, and in most unexpected ways (as writer of this could testify), help on the good work.

Simplicity of operation, under the established water rates, appears to the writer to be of prime importance, and to attain this in the greatest degree seems to him to be reason enough for rejecting the plan of front foot assessment described in the report of the committee.

The substance and service furnished and to be paid for consists of water, under pressure, delivered into the consumer's premises. It is valuable not only as water, but also as an ever-ready safeguard against losses by fire — this last being of value, even though no water be actually drawn for a long term of years.

Water rates may, therefore, very properly consist of two parts: water supplied, and water held ready for extinguishing fires. Water actually used for extinguishing fires is so small in amount during the year that it does not disarrange the accounting to omit it from charges to be made.

We have then the insurance saving to the community by the presence of water under pressure, by hydrants, etc., which may well be a common charge to the whole community, to be paid for out of the tax levy; in a lump sum; or as hydrant rentals; and, secondly, water delivered in varying quantities to consumers.

Now, why it should make any difference to the water department what use the consumer makes of the water received, or where he uses it, the writer does not see, except in cases of a

* Hydraulic Engineer, No. 2 Wall Street, New York City.

scarcity of supply, when luxurious uses — lawn-sprinkling, for example — may, by exercise of police-power, be prohibited altogether, for the purpose of preventing the failure of any citizen to receive a necessity of life.

The foregoing being accepted, we next arrive, naturally, at the selling of water by measure, or by meter. The writer's conception of a water meter is an instrument that will enable the total annual cost of a water supply (less hydrant rentals received) to be equitably distributed among its beneficiaries. Everything hinges thence on upon people's ideas of what constitutes an "equitable" distribution of this annual cost among the water consumers. And this, being an off-shoot of the great subject of taxation, gives room for opinion and for argument.

To the writer there is but one simple way, — to charge by quantity used and wasted; that is, "consumed" on the premises.

If manufacturers, especially such as use large quantities of wash-water, are to be favored, as an inducement to settle in the community, or not to leave it, two ways present themselves for exercising such favoritism — their taxes may be remitted in whole or in part; or the principle of a sliding scale for water rates, based on quantity consumed, can be introduced.

The business of booming a town by means of charitable bequests in aid of coming or existing manufacturers, should not, however, be confounded or mixed up with the distribution of the annual cost of the water supply among those who receive water.

If it costs $50 000 annually to supply 1 000 000 000 gallons of water, this makes the cost per million gallons to that town $50. And if anybody pays only $30 for his million gallons of water consumed, then somebody else must pay the other $20. Shall it be the other water consumers, or the tax levy of that town? As a public or communistic enterprise, thus to relieve present, or to tempt intending resident manufacturers, there would seem to be more reason for meeting such charitable expenses from the common tax levy, than for saddling them upon the water takers alone.

For municipal water departments, this is not a parallel case to making a difference between wholesale and retail rates for an article offered for sale, for the reason that in the case of such articles, a profit is to be arrived at; and wholesale rates, though they

include a smaller profit per unit of measure than do retail rates, yet produce more of a profit in the aggregate.

But municipal water rates are not based on, or intended for the making of a profit. Their aim is merely to distribute in an equitable way, after the manner of mutual companies properly managed, such as savings banks, etc., the annual cost of carrying on the business, among its beneficiaries.

Should, however, the sliding scale of water-rates, from retail to wholesale quantities, be adhered to in the case of private water companies, or in the case of municipal water works who wish to range themselves in the company of sellers at wholesale and retail rates, such a sliding scale, diminishing with an increase of consumption, can readily be made to favor the large consumer. In such cases, the sliding scale should not include a temptation to consume more water for the purpose of attaining a lower rate and a lower aggregate charge.

An objection to meter rates, often heard from, relates to low-priced tenement houses, where waste is liable to go on in excessive amounts, and is not brought home to the wasters by the one meter in use as it is where only one family occupies the house: hence great outcry and objection from the owners of such tenements. But the remedy is clearly the use of more meters; one on each floor, or if need be, one to each family; precisely as the gas company manages such cases. There is no way to gain the active and continuous coöperation of the public in keeping their plumbing in order, and in shutting off the water when it is not being drawn for use, except by causing the result of any neglect on these lines promptly to appear in the next quarterly or monthly bill for water used and wasted.

It is to be regretted that the report of the committee gives renewed currency to the exploded fallacy that, with a gravity supply, "it costs no more (within certain limits) to furnish a large amount of water than a small one." This is equivalent to saying that wastefulness costs no more than thrift, and the day when this shall be true is surely as far distant as the suspension of the action of the force of gravity, or of that of any other law of the universe. The statement made by the committee is apparently — but only apparently — true for one year of operation, but is evidently not

true for ten or twenty-five years, or longer. Working on the basis first named has called for tens of millions of dollars of expenditure for "extending the water works" in the United States, when for ten and twenty-five years, even for fifty years, such expenditures should have been uncalled for and unnecessary. It also breeds a spirit of wastefulness in any community, with an article costing money to procure, which later it is exceedingly difficult again to remove. It has been largely responsible for that very disinclination to use reason in the management of water works, which the report of the committee aims to annul. No city receiving and paying for water by meter would ever think of putting forth such doctrine.

It is well to remember that cases are on record in which by nurture of the spirit of wastefulness, cities have attained a consumption on certain days of fully ten, and even twelve times the quantity which was ample for all their needs, and it requires no argument to prove that such cities have paid, and are paying, much more for water than they should, be it furnished by gravity, or by pumps, or both.

House meters are necessary for the prevention of waste on the consumer's premises. Equally necessary for the prevention of wholesale waste out of street mains and conduits, and, generally, to enable a proper accounting to be made of the whole operation of the works, are Venturi meters on these mains. The experience of the Metropolitan Water and Sewerage Board of Massachusetts should be conclusive on this point; not to mention that of the East Jersey Water Company, the details of which (this being a private water company) are, however, not so easily procured.

Nor can a counting of pump strokes take the place of a meter record, whether this be an occasional one, or a graphically continuous one. In fact, it has repeatedly been shown that the only way to keep a pump constantly in order is to have its pulse felt from time to time, or daily, by a meter; and to make repairs on valves or do other overhauling as the meter shows the need of them Without such watch upon the pump, counting the strokes may result in a variance from the truth of anywhere from 20 to 40 per cent.

As a final consideration, and with reference to flexibility of rates from one year to another, the writer suggests discounts on bills paid, or to be paid, precisely as this end is attained by the

general tax levy, or in the management of mutual savings banks, or mutual life insurance companies. It is very true that it is difficult to foretell the income and expenditures of a water department, and, generally, that the historian has a clearer field than the prophet. But such estimates need be no more embarrassing to the water department than they are to the other communistic enterprises above named.

All perfection in this world, or approach to it, is generally reached by successive steps of improvement and of approximation. Let any fair and competent estimate be made, therefore, of annual income and expenditures for the ensuing year; make an "overlay," precisely as the tax levy does, to prevent shortage, and then let the water takers have the benefit of the surplus, either at the office in cash, or as a discount on the next quarterly bill, or annually. Such annual rebate might even be made a popular feature of the conduct of the water department, awaited with interest, and no doubt meeting praise and blame, according to amount of cash thus put into the pockets of the water takers—where now there is blame only.

We have thus arrived at the conclusion that waste should be prevented and water paid for as gas or the electric fluid is managed and paid for: namely, strictly by measure of substance consumed on the premises through the meter of the party furnishing it, at uniform rates to all consumers, with the additional and superlative attraction that all profit (or in case of private water companies, all excessive profit, if any), made during any one year, is returned to the customer, pro rata, at stated intervals.

Mr. Allen Hazen.* The report of this committee marks an important forward step in the question of fixing meter rates. It recognizes a fundamental principle which, if carried to its logical conclusion, would go a long way towards doing away with the objection to meters.

It is altogether reasonable that the income to be derived from the sale of water should be made up of two parts, one of which is dependent upon the amount of water used, and the other of which is not. The latter class of expenses is represented by long lines of pipe, and by other parts of the system provided and not directly

* Consulting Engineer, New York City.

affected by fluctuations in the amount of water used, by the expenses of meters, services and book-keeping, and administration expenses generally.

Recognition of the fact that a certain proportion of the income is to be obtained for these matters, that is to say, as payments for the sake of having water available when it is wanted, will allow a lower price per thousand gallons to be put on water sold by meter. This will tend to prevent much of the dissatisfaction with meters, which comes, I think, from the feeling that the amount paid under existing schedules is often in excess of the fair value of the service, and I am afraid that there are cases where this feeling is fully justified.

The report of the committee will also tend to the simplification of schedules of meter rates, and to the adoption of more uniform methods. The variations of the schedules in use in different cities are surprising. A few years ago I prepared a diagram showing the amount of water which could be bought at meter rates in a year for given sums of money in a number of cities. This diagram is reproduced herewith (Plate I), and also a tabulated statement of some of the quantities.

TABLE SHOWING THE COST OF THE QUANTITIES OF WATER STATED AT METER RATES IN VARIOUS CITIES, IF DRAWN DURING A PERIOD OF ONE YEAR. COMPILED IN 1899.

Quantity of Water per Annum	Water Quantities in Thousands of Gallons.									
	10	20	50	100	200	500	1 000	2 000	5 000	10 000
Grand Rapids	$5 00	$5 00	$6 33	$13 33	$26 66	$66 66	$93 33	$186 66	$366 66	$600 00
Lancaster,	10 00	10 00	10 00	10 00	10 00	25 00	50 00	100 00	250 00	500 00
Milwaukee,	1 60	2 20	4 00	7 00	13 00	31 00	61 00	121 00	301 00	601 00
Albany,	6 00	6 00	6 00	8 00	16 00	40 00	80 00	160 00	400 00	800 00
Reading,	5 00	7 70	13 80	21 20	30 40	48 10	70 00	110 00	220 00	385 00
Madison,	4 50	5 20	16 00	23 20	36 60	62 00	85 00	130 00	330 00	660 00
Syracuse,	5 00	5 00	9 20	18 50	30 70	73 10	105 00	165 00	240 00	465 00
Berlin,	5 40	6 60	10 70	17 60	31 20	72 00	140 00	280 00	680 00	1 370 00
Lawrence,	5 00	5 00	10 00	20 00	39 00	93 00	170 00	320 00	720 00	1 300 00
Pittsburg,	5 00	5 00	10 00	20 00	40 00	100 00	195 00	345 00	600 00	1 000 00
Providence,	5 00	5 00	10 00	20 00	40 00	100 00	205 00	400 00	900 00	
Paterson,	5 00	7 10	14 20	28 40	54 00	89 00				
Paris,	4 00	6 40	12 00	24 00	48 00	115 00	220 00	380 00	760 00	1 300 00
Fall River,	2 80	5 60	14 00	27 40	53 20	110 00	200 00	350 00	730 00	1 200 00
Newton,	10 00	10 00	17 50	35 00	70 00	175 00	350 00	600 00	1 000 00	1 500 00
Gloucester,	5 00	10 00	25 00	50 00	100 00	250 00	470 00	850 00		
Average,	$5 25	$6 36	11 80	$21 50	$39 90	$90 50	166 00	$300 00	$535 00	$899 00

The difference in local conditions, in the cost of water, etc., may justify many of the variations in these meter schedules; but certainly such conditions cannot account for the wide differences shown, and particularly for the way in which the charges sometimes increase with progressive amounts of water used.

Some of the cities represented were clearly selling water to their largest consumers for less than the cost of producing and delivering it, at the same time charging small consumers rates proportionally above those necessary on an equitable basis for meeting the requirements of the works.

It is only fair to say that this information was collected some years ago, and that many of the cities represented have since corrected their schedule of rates. I present it without revision to illustrate the wide and unreasonable fluctuations in different cities, and not as a basis for criticism of any individual case.

It will be noted in the diagram that two of the schedules shown, namely, the new schedule of Berlin, Germany, and the schedule of Milwaukee, have anticipated to some extent the report of our committee. That is to say, a charge of $3 per year for the service is made at Berlin, and of $1 per year at Milwaukee, and all water used is charged for at meter rates in addition to this, the idea being that the first item is an approximation to the expense of maintaining the service and meter, although the Milwaukee rate is undoubtedly too low to do this.

In large cities this scheme has something to recommend it. The proportion of the total expense, which varies with the quantity of water, would generally be larger in a considerable city, where the water works are used to a large per cent. of their ultimate capacity, than it would be in smaller towns, and particularly in places where works have been recently installed and the consumption is only a fraction of that which might be supported from existing works.

The method used at Milwaukee and Berlin is in line with the recommendations of the committee, but it is even simpler, and it seems to be particularly adapted to the larger cities.

I indorse the report of the committee most cordially, at the same time recognizing, as does the committee, that the exact method of distribution and computation employed cannot be a

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WATER RATE + DOLLARS PER YEAR
MILLIONS OF GALLONS PER ANNUM
30 GALLONS PER CAPITA FOR A FAMILY OF FIVE FOR ONE YEAR
30 GALLONS PER CAPITA FOR A FAMILY OF TEN FOR ONE YEAR
GLOUCESTER, MASS.
NEWTON, MASS.
PATERSON, N.J.
FALL RIVER, MASS.
PARIS
BERLIN
MADISON
PROVIDENCE
FALL RIVER
LAWRENCE
NEWTON
PARIS
PITTSBURG
ALBANY
MADISON
LANCASTER
READING
100,000
200,000

METER RATES IN VARIOUS CITIES. — ALLEN HAZEN, 1899.

universal one, but must be subject to study and adaptation to local conditions.

Mr. Edward W. Bemis.* It has been necessary in my conduct of the water department in Cleveland to study this question very carefully. To-day Cleveland has one fourth as many meters, and meters one fourth as much water as the entire total shown in the table presented by the committee. We have in use now 40 000 meters; four years ago we had only 3 000. We set 2 600 last month and will set as many more this month. We will set 15 000 this year. We have now everything metered except about 25 000 house services. We have metered about 40 000 services, large and small, and we are metering the others as fast as we can. Every service requiring a meter larger than a ¾-inch is metered — every city building, every schoolhouse, every drinking fountain.

Having studied the question in this way, I should like to speak of one or two matters which are suggested by this report.

First, it seems to me that the discussion by Mr. Herschel has merit in calling attention to the fact that even in a gravity supply the waste of water is important, and for the reason which he has mentioned but which the committee did not seem to take into account, viz., that every ten or twenty years you have to extend your plant to reach new sources of supply, if there is a large waste.

The feature of the report of the committee which struck me as being very valuable was the idea of making the abutting land pay for the fixed charges, a matter which I notice Mr. Hazen has approved. That is certainly admirable. I have often desired information as to the extent to which abutting land pays for laying the water-pipe in the first place. I understand that in Milwaukee that is done in the case of all 6-inch mains outside of street intersections — that the entire cost of laying 6-inch mains is paid by a special assessment on abutting property. A recent law in Ohio allows that to be done, and it is being done. For instance, Lakewood, a suburb of Cleveland, is laying its water mains in that way.

And it seems to me that this is a very correct method, and one not at all out of harmony with the report of this committee, because the laying of a water main increases the value of the land

* Superintendent of Water Works, Cleveland, Ohio.

on the street more than the cost of the pipe. I hope some of the gentlemen here who know something about this matter will give us some information as to what other places, outside of Milwaukee and one or two cities I know of in Ohio, are doing in the way of making special assessment for laying water mains. That is certainly a matter which ought to be inquired into.

The difficulty, however, in applying the principle of the committee to the assessing of water rates, is, I think, especially to be considered in the case of large cities that already have their water supply. It looks to me like an admirable system in theory, and one which I think would work well in the introduction of a plant in a community, but there would be certain difficulties in applying it to a large city like New York or Boston or Philadelphia. There would be the conservatism to be overcome in the community, the application of a new principle of taxation for water works, something different from what the people are accustomed to, and something with which they are unfamiliar; and while that is not a fatal objection, it will, I fear, make the introduction of such a reform very slow; and it may, therefore, interest members of the Association to know how we attempted to tackle the problem in Cleveland.

We had to face the same difficulty which the committee had to face in introducing meters. We wished to make them popular, and we wished at the same time to foretell to some extent what the effect on our revenue would be. Of course we could not do that fully at the start. We have learned since much more than we knew at the time as to how little water is used by the average house consumer. We have had an analysis made of our 30 000 meter bills which were presented for payment in April; and I find that, excluding about 4 000 large meters, one half of all the rest average only 2 000 feet of water in six months, and one half of that number, or one fourth of all the residences, average only 1 500 feet, the other quarter of the residences averaging 2 500, making one half, or over 11 000 — about 12 000 of our residences out of those that we have metered — averaging only 2 000 feet of water.

In order to prevent too great a fall in revenue, and yet not interfere too much with the accustomed mode of getting revenue,

we adopted a series of minimums based on the assessment rate. Our rates were low anyway to start with, and yet we wanted a minimum so low that everybody would gain something by having a meter. It would not do, therefore, to have one minimum for ¾-inch meters, but the great problem was how to fix a minimum for ¾-inch meters, and yet make it an object for everybody to have a meter if he were prudent in the use of water. We adopted four minimums to start with. Those whose annual rates were $4 or less could have a minimum of $2.50, unless they used more water. Of course if they used more than $2.50 worth of water they had to pay for it, but they had to pay $2.50 anyway. That was paid in semi-annual installments, $1.25 each six months. For those whose annual assessments were $7 or less, there was a $4 minimum, payable semi-annually. For those whose assessment rates were $10 or less, the minimum was $6, and for all others having a ¾-inch meter the minimum was $8. Of course these particular figures would vary in other cities, but the idea of having four minimums struck us in Cleveland at the time as perhaps the only practical solution of the problem. We have since reduced those four classes to two, and we now have a $2.50 rate for those whose assessment rate is $7 or less, and a $5 rate for all others using a ¾-inch meter.

The other plan that we considered was the Milwaukee plan. Milwaukee, as you know, has between 30 000 and 40 000 meters, — nearly 40 000, — which have been put in at the expense of the consumers of late years. There they do not have any minimum, but they charge a dollar a year for reading the meter. That system has its advantages, but the trouble with that, as we thought, was that if the city is advertising that it is putting in meters for nothing, as we did, we didn't think people would quite understand our turning around and charging them for reading the meter, and we really accomplished the same thing by our minimums. Our minimums do actually average two dollars a year for all the house meters in the different classes. So we have accomplished what they have attempted to do in Milwaukee, and we have at the same time met the great objection that has been raised by physicians against meters, that people wouldn't use enough water for their health, particularly in the poorer sections of the city and

where there are very hard landlords; for with our very low rate for water, of 40 cents per 1 000 feet, the minimum of $6 would allow the use of 129 gallons with a meter every day. So we entirely spiked the guns of those who were objecting to meters on the ground that they would restrict the consumption unduly.

Now we do not consider that scheme as scientific as that suggested by the committee of having fixed charges apportioned by special assessment, either on the entire land, which they intimate might be the better way, or on the improved property, which they think perhaps would have to be done as a matter of practical expediency. But I think, perhaps, it is easier of adoption and would accomplish a great deal in the way of getting at what we are after in cities that already have adopted the assessment rates, and where it is desirable to introduce meters without waiting for too great a reform in the method of obtaining revenue.

(*By letter, September 26.*) On further consideration of the report of the committee I conclude that this suggestion — to have the fixed charges paid by a special assessment on improved property — is not very different from the proposition that the city should pay the water department a liberal amount for fire protection and water for other public purposes, and should raise this amount out of the general tax levy. This would secure money not only from improved property, but from the unimproved, which the committee admits ought to pay something. This would not interfere with the suggestion I made in my discussion in New York that 6-inch mains should be laid by special assessment on all the abutting land.

Mr. Charles W. Sherman.* The committee, although they do not say so in so many words, practically recommend a flat or uniform price for metered water after the minimum assessment has been paid. That is undoubtedly desirable in theory, and in many cities, perhaps, can be practically applied with satisfaction to all parties. It is not, however, always possible to do that, especially in the case of private water companies. A number of rates per 100 cubic feet or per 1 000 gallons is sometimes practically necessary. And in that connection I want to state as an example of "how not to do it" the rates of a private water com-

* Civil Engineer, Boston, Mass.

pany in Indiana which recently came to my attention, those rates having been fixed by the franchise of the company.

For a consumption not exceeding 100 gallons per day the rate was to be 40 cents per 1 000 gallons. For a consumption between 100 and 200 gallons per day the rate was to be 30 cents; between 200 and 300 gallons it was to be 25 cents; and between 300 and 1 000 gallons per day the rate was to be 20 cents per 1 000 gallons. No rate was fixed above 1 000 gallons per day. As you will readily see, a customer using between 200 and 300 gallons will pay the 25-cent rate for all his water; consequently there will be a point under that rate at which a man using say 201 or 202 gallons per day would pay a less total sum than a man using 190 or 195 gallons per day, if the rates were strictly adhered to. As matter of fact, I believe this particular company has made it an office rule that they would charge no party more for a smaller quantity of water than he would have to pay if he had used a larger quantity, although I do not know that that is specifically advertised. Under the company's rule there would be a certain range of consumption within which, therefore, the bill would remain the same whether the party used more or less.

What I wish to emphasize is the desirability, in case a variable meter rate seems necessary in a water system, of following a method by which the first 10 000 gallons per quarter, or whatever is a convenient unit, be charged for at one rate, and the next 10 000 gallons or some other fixed quantity of water, be charged for at the next (reduced) rate, the higher rate, however, applying, even in the case of a large consumer, to the first fixed quantity of water.

Mr. Walter H. Richards.* Mr. President, this subject is of interest to every water-works superintendent, if not at the present time, it is likely to become so very soon, because it is evident that we all will have to use meters in order to have water enough to go around. As to the rate, it seems to me that it is simply a business proposition. You have got so much water to sell. It has cost you so much to get it to the point where you wish to deliver it. Now, if you divide what it has cost you, that is, interest on your outlay and the cost of maintenance, by the

* Superintendent of Water Works, New London, Conn.

number of gallons you can furnish, you get approximately the lowest rate per 1 000 gallons. After you have got the water into the city, then it costs you something to get it into a house, and for a large quantity it costs you more than for a small quantity; hence you should have a minimum rate which varies. That is, a minimum rate for a small service pipe would be less than a minimum rate for a large service pipe. And I think we should have different rates, — that is, the rate should be less for a large quantity than for a small quantity. For I think we should consider somewhat what water is worth to the man who uses it. Of course it is worth more to the man who drinks it than it is to the man who uses it for manufacturing purposes — to make steam — and that should be considered in making up the rates. There is a large expense to keep the water pure; sometimes it has to be filtered, and all that is for the benefit of the householder — the man who drinks it — and hence he should pay a larger rate than the man who wants the water only for the purpose of making steam. It seems to me that each city should have a rate based upon its own peculiar circumstances, depending largely on what the water costs, but also upon other considerations.

Mr. T. H. McKenzie.* There is one point which I think the committee have not covered in their report; that is, the matter of the life or term of usefulness of meters, or the length of time they can be used before they have to be removed and new ones substituted. I haven't very much experience with meters, but I will mention one instance where we put a 4-inch meter into a mill. At the time we put it in the mill was running only nine hours a day, but afterwards they commenced to run twenty-four hours, and in three years and a half the meter was practically worn out. We found out the condition of the meter in this way: the mill was using some 350 000 gallons of water per day; they substituted pumping for some uses — for cooling the furnaces and that sort of thing — and used our water only for boiler purposes; we found that certain days, when they were running perhaps six or seven hundred horse-power, the meter scarcely moved. Of course most of the small water works do not have facilities for testing meters and determining when they are worn out and when they

* Treasurer Water Company, Southington, Conn.

should be removed. I think that people who have had a large experience with meters can tell us something as to the ordinary life of a meter, either in terms of years or in quantities of water passed by the meter.

Mr. Hugh McLean.* I suppose this committee's object was to report on a uniform rate for selling water. Now, as I understand it, what we want to get over are the objections to putting in meters by devising some rate which will be as equal and equitable as possible; for instance, we put a meter in for a consumer, and the rate, we will say, is a sliding rate of 15 cents a thousand for the first 100 000 gallons, 10 cents for the next 200 000 gallons, and for all over that it is 5 cents per 1 000 gallons. We want to make it as easy as possible to get the meters in. Some user would say, "Why must I pay 15 cents for all my water?" And another would say, "Why should I pay 10 cents for mine?"

The idea I advanced at our meeting in Boston was to abolish these different rates, and to have one flat rate for all consumers, and in that way get rid of the objection to putting meters in, and make the matter very simple. The small consumers say, "We are citizens, we are equal shareholders in the water department with the large consumers of water, and we are entitled to have the water at as low a rate as the largest consumers; in fact, we ought to have the preference because we use it to drink, and to keep clean, and they use it for power and manufacturing purposes." When you start to put meters in, that objection faces you right away. So I argued in favor of abolishing the different rates and making one flat rate, which shall be as low as possible and keep the revenue up to what it was before.

Carrying out that idea, our water department has abolished the 15-cent rate, and we have now only two rates,— the 10-cent and 5-cent. By abolishing the 15-cent rate we lessened our revenue about two thousand dollars, but we added meters so that we increased our revenue about two thousand five hundred dollars and decreased our consumption from 159 to 105 gallons per capita — a saving of two million gallons a day. Now we propose to continue, and on the first of January we may abolish the 10-cent rate and have only one flat rate, and we expect the peo-

* Member Water Board, Holyoke, Mass.

ple will then allow us to put meters in, because we can say in all justice, "This water belongs to the community, to all the citizens equally, and we propose to see that it is sold at the same price to all." As it is now, the man who is using a small quantity pays twice as much for it as the man who is using a large quantity; and how can you stop that injustice, the giving of that benefit to the large consumer over the small consumer, unless you have one flat low rate?

Many business interests to-day are consolidating, and as a result they are getting water at the cheap rate. For instance, a mill which used 200 000 gallons of water every month paid 10 cents per 1 000 gallons for it. But 20 mills combine under one name and call themselves the American Paper Company, or whatever name they choose, and the 20 mills have their water bills lumped together, and they get all their water above the first 200 000 gallons at the 5-cent rate. Now how are you going to stop a consolidation like that from robbing your department, because the various concerns become one individual after they have consolidated, and they will buy the water as one and not as many?

The only fair, equitable way for a municipal department is to sell water to all the citizens at the one flat rate, which shall be as low as possible and yet furnish the revenue necessary to operate the department.

Now so far as the recommendation to assess property is concerned, I think that would be a step in the wrong direction. It would be in the line of double taxation. You might just as well argue that you should tax property for putting in gas pipes or electric-light wires or street railways. All those things increase the value of the adjoining property, and the owner of the property really has to pay for the improvement in value by increased taxes.

I think the simplest way is to charge so much annually for every hydrant for fire protection. That guarantees you a stated amount for each hydrant set by the department. As far as meters are concerned, the preferable way in my opinion is to set up the meter for the consumer and charge him a certain per cent. on the cost of the meter and for the labor in maintaining it, keeping it in good condition and reading it. If a meter costs $12, charge him say 10 per cent. on the investment, and that will be coming

back annually in the form of interest on the money you spend for meters. There should be only one price charged for water, just the same as there is only one price for any commodity that the government sells. Gas is sold at so much a thousand feet, the same to everybody; electricity so much a kilowatt; and water should be sold in the same way. That is justice, and all citizens are entitled to it.

Mr. Frank L. Fuller.* It has always seemed to me that the first use of water was for the householder, for the man who has to use it to supply his family. This is what the system is primarily introduced for. Now, why should a man who uses water for profit get it for a less price than a man who uses it from necessity, who must have it for the use of his children and for the ordinary domestic purposes? I think probably the large percentage of domestic consumption is by families in moderate circumstances, — a good many of them poor families, — who cannot afford to pay too much for their necessities. Why should a man who makes money out of the water, who uses it for manufacturing purposes, for making steam, etc., get it at a less price than the man who makes nothing out of it, but who uses it from necessity? In Wellesley we have one rate, and I thoroughly believe that, for the ordinary country town, that is the proper method. The greenhouse people there say, "We are using this water in our business, we get our living from our greenhouses, and we think we ought to have it at a cheaper rate." But our reply has generally been, "You use the town water because it is the cheapest water you can get; it is cheaper for you to use this than it would be to pump it yourselves; you make money out of your flowers, and why shouldn't you pay just as much for the water as the ordinary man who has a family, who makes nothing out of the water?" It seems to me that there is a good deal of force in that argument, and, so far as my observations have gone, that a reasonable flat rate is the better principle to go on.

Mr. F. A. W. Davis.† This discussion may be getting tiresome to some of you, but the questions present so many different features and affect such different interests that it takes some time

* Civil Engineer, Boston, and member water board, Wellesley, Mass.

† President, Indianapolis Water Company, Indianapolis, Ind.

to go over the entire ground. Some suggestions have been made which I should like to answer. I am not going to criticise the report of the committee, for I think that it is an able report, and it certainly shows that the committee has spent a good deal of time upon it and given the questions considerable thought.

The reasons for setting meters are different. Some of them are as follows:

1. To stop waste.
2. To increase the revenue.
3. To avoid increasing the size of the mains.
4. To prevent surreptitious use of water.
5. To prevent one neighbor from supplying another.
6. To ascertain if consumers are paying as much as they should.

There may be other reasons, but these are sufficient.

It is somewhat experimental to set meters to increase the revenue, for it has often proven the means of reducing the revenue.

As to the use of meters making it unnecessary to increase the size of mains, it is questionable. Mains should be adequate and of sufficient size, for we are not at all times able to determine if it is legitimate or illegitimate use that incapacitates certain mains from delivering a reasonable supply to the citizens on the lines.

To prevent surreptitious use and neighborly accommodation is commendable.

So it is, in setting a meter, to ascertain if the quantity of water taken and paid for under the flat rate is greater than it should be. It has been found in the experience of nearly every water works that there are cases where the quantity of water used does not yield a revenue of one cent a thousand gallons.

The waste problem is comparable to that of taking coal without pay. A man without money, and with a family to warm, gets a wheelbarrow and helps himself to the coal pile of the water works. His visits become frequent and by and by he is detected, arrested, and sent to the workhouse. The man who wilfully throws down the hose on the lawn, turns it into the sewer or street, or allows his fixtures to run continuously, does for the water works the same thing as the man who takes the coal away in the wheelbarrow, the only difference being that in the first case the family get some benefit from the coal, while the man who wastes

the water gets no benefit for himself or others, and yet he gets away with the coal of the company. It may cost the company only hundreds of pounds of coal to furnish that man water, but if he makes it cost thousands of pounds of coal, he does the same thing as the man who takes it away in the wheelbarrow, for they both get away with the coal of the company without compensation. In this case, it would seem that a meter is necessary to correct his conscience.

As to the rates for metered water, they should be adequate to meet the requirements of the works in the city where located. What is just and equitable in one place may be onerous and burdensome in another. A single rate is not proof against trouble, and, as a matter of fact, is not more equitable than the graduated rate. The one rate may be fixed at what seems a safe basis. Then comes a time of depression in business which forces economies in every way, and the water department comes in for a reduction of its revenue by reason of the decrease in the demand for water, so that the revenue will not pay interest and operating expenses. The deficit must be met by raising rates or increasing taxes, to which there would be serious objection on the part of the people. Often the raising of the rate, or increasing taxes, means loss of power by the political party in control.

There is less office work in a single rate, but the graduated scale saves the department from embarrassment and loss, and is safer as a business proposition than the single rate. The single rate may be more popular, but it does not save the department from trouble. If you tax your memories, you will recall that the single rate is often shaded for large consumers, notwithstanding the fact that it is intended to be alike to all. When the shaded rate becomes known, then there is trouble. Objections are made to giving a lower rate to manufacturers using a large quantity of water. The graduated scale permits furnishing them water at a rate based upon the quantity used, and it is not a violation of the rules of the department governing rates, and is in accord with the business methods of the country. A man who puts forth energy and skill is entitled to recognition of his ability. Without some incentive, the best results are not obtainable. A man who establishes a business and becomes a large consumer

of water is entitled to have the water furnished at the lowest possible rate that is fair to the water works, for the reason that his establishment adds value to the city and he becomes a large tax-payer and a supporter of a large number of people by furnishing them employment.

Often at the one low meter rate, the earnings of many of the meters are not equal to the cost of reading the meter, let alone paying interest and the maintenance of the meter.

A reasonable frontage tax is justifiable upon property along a street in which a new main has been laid until there is sufficient business developed on the main to prevent a loss to the city. In the case of a private company, the city pays the company a hydrant rental which covers all the water used for fires and the flushing of sewers. It is generally supposed that the hydrant rental is an expense to the city not reimbursed, but the taxes paid by the water company on its mains and hydrants, and the taxes paid by the people who were induced to build houses on the street by reason of the laying of the main, constitutes a permanent source of revenue to the city, which usually exceeds the amount paid for hydrant rental, besides adding to the value of the property along the street in which the main is laid.

Frontage tax can be imposed by the city, and is a means of obtaining revenue that a private company cannot avail itself of. In the case of the city, if the revenue is not sufficient, the tax-payers are obliged to keep on maintaining the works and paying the interest upon the bonds issued to build the works. The bonds and stock of a private company are often held by estates, retired business men, orphans, trust companies, and savings banks. Therefore, the company should not, under any circumstances, make rates that would not at all times and under all circumstances furnish sufficient money to maintain the water works, pay interest upon the bonds and a reasonable dividend to the stockholders. By so doing it gives stability to its securities.

Meter rates should be graduated so as not to furnish more water for less money or induce a waste, in view of the constantly increasing cost of water, made so by expensive filtration systems, getting water from a greater distance, and the storing of water which is made necessary by the water's continually growing

scarcer. To me it does not seem like a reasonable business proposition to make the same rate for 100 as for 1 000 000 gallons. If the one rate is made too high, then the department does not get the business; if too low, it is equally unfortunate. I do not know of any water works that does not recognize the principle in a flat-rate schedule by selling the second bath or closet at less than the first. If this is right in a flat-rate schedule, why not in a meter schedule?

MR. W. C. HAWLEY.* I think we must all recognize that this report is a step in the right direction, and one which will be of benefit to a great many water plants. I do not, however, want to leave it in the position of its being the unanimous opinion of those present that this is a principle which will apply in all cases, and that the rates computed in the cases cited — 5 cents to 15 cents per thousand gallons — are rates at which our private companies should be selling water. As a rule the rates which private companies can charge are fixed in their franchises, and it is an absolute impossibility to change them in accordance with any suggested schedule, however desirable that schedule may be. This report enunciates a principle which can be followed by many municipalities, but it cannot be followed by more than a very few private water companies.

There is one matter which occurs to me in connection with this report regarding the assessment on frontage. That is probably a very equitable way of getting at it in a small town. But in these days of skyscrapers and apartment houses, I think that the height of the building should enter into the assessment, especially in the larger places.

This matter of a uniform rate is simply a question of wholesale and retail business. You cannot draw the line too finely, and undoubtedly a flat rate is the proper thing in a majority of the smaller places; but any water works man knows that it costs more money so sell ten million gallons, we will say, in a year through one thousand meters than it does to sell ten million gallons to half a dozen consumers through half a dozen meters. There is the care and maintenance of the meters, the bookkeeping and reading and all that sort of thing entering into it, and it is a

* General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa.

question of the cost. You cannot make a uniform price any more than the storekeeper can put his calico and his silk at a uniform price.

The opposition to meters, in my experience, comes from two sources,—ignorance and politics. Once in a while we get a combination of the two, as we have recently in a western Pennsylvania city, in which the ignorant politician has made an exhibition of himself which I think surpasses anything which has ever been seen in this country previously. But once the meter system has been introduced and people have become used to it, it would be many times more difficult to take the meters out, and go back to the fixture rate, than it was to introduce the meters in the first place.

One gentleman in discussing the report, as I understood him, expressed the idea that no difference should be made between the uses to which the water should be put. My experience is that you must make a sharp distinction between the water that is used for fire protection and that used for other purposes, especially in the smaller classes of mills, such as those which do not come under the Factory Mutual Insurance Companies. They will want a 4- or a 6-inch service where a 2-inch or a 3-inch would be ample, and they will want to attach their sprinkler system to it and fire hydrants, and they won't expect to pay you a cent for the fire protection which is afforded unless they should use the water, and then they want it at the low meter rate. Our company to-day is making a distinction in its contracts. We prohibit absolutely the use of any water for fire protection under a domestic or manufacturing contract, and require a separate contract and a separate service for fire protection. I think that is a principle which is just and right. There is a cost for fire protection service which does not enter into the supplying of water for domestic or manufacturing purposes, but which is distinct and separate from it, and the private company or municipality is entitled to payment for that.

Mr. Robert J. Thomas.* Of course in New England our conditions may be somewhat different from what they are with the private companies in the West in the matter of not being taxed directly, but superintendents of water works in New

* Superintendent of Water Works, Lowell, Mass.

England know that they are taxed in an indirect manner, at least, — that is, a considerable portion of their revenue has been taken away. In some cities the municipal water works have to furnish free water to the schools, public buildings, fire department, and to the park department. So in that way we are being taxed indirectly and we have to allow for that in making our rates.

In the matter of a sliding scale, our water boards have had to take into consideration that there are manufacturers in our New England cities who, if they did not get water at a certain price, — that is, at the lower scale, — would put in their own water works. In that way they are really depriving the water department of its proper revenue, and are postponing still further the time when the city can reduce the rates for all takers.

So we look at it from different standpoints. Mr. McLean of Holyoke thinks we ought to have a flat rate. Down in the eastern part of Massachusetts we think that the sliding scale is the thing and that we ought to cater to some extent to the manufacturers in order to induce them to become customers of the water department, that our revenue may be thereby increased, and that we may be able in that way to sooner reduce the charge to the small consumers. So you see that even among municipal water works' officials, even in the state of Massachusetts, there is a difference of opinion on these matters.

Mr. Frank C. Kimball.* I have to do almost wholly with private corporations, and I have dealt with such corporations not only in New England but in the South and the West. The committee in presenting their report have given us, I think, some very valuable suggestions to consider. In several instances where it has fallen to me as a part of my duty to prepare schedules I have run across a number of difficulties, as undoubtedly the committee have — as is somewhat shown in their report — and which have been referred to by members here to-day. For instance, in the matter of a minimum rate, I think it goes without saying that a minimum rate is an absolute necessity. Even Milwaukee, which boasts of having no minimum rate, does really have one under the guise of a charge for reading meters, although to be sure it is a

* Civil Engineer, Boston, Mass.

low one. And the point which was brought out, I think, by Professor Bemis, that Milwaukee also requires all their 6-inch mains to be paid for by the abutting property, is a charge equivalent to a minimum rate in itself. Of course private companies cannot do that, but still as he has asked for experiences along that line, I will say that one company I have had to do with has in effect done the same thing in this way: In developing land, when, to bring it into the market to sell to good advantage it has been necessary to have water mains and a water supply, the company has laid such mains entirely at the expense of the owners of the land, but under a contract whereby those mains, of course, belong to and are under the control of the water company; the company on their part agreeing to pay back to the owners of the land from one half to two thirds of all the revenue received from the sale of water from those pipes until they receive in return all that they have advanced. That is one way that private companies can get a part of this money, or at least be sure of a revenue from their investment. Still they do, of course, labor under greater disadvantages than do municipal corporations.

The question of a minimum rate based, as I understand it is at Cleveland and at some other places, on the fixtures in a house, hardly appeals to me from the fact that one advantage of a meter is that it does away with the annoyance of house-to-house inspection. People as a rule dislike to see a water-works inspector rummaging about their houses, in their closets and bath rooms and other places, to see what fixtures they have got. Adopt a minimum based upon fixture rates and you still have to make house-to-house inspections, possibly not to the extent that it is done when rates are based upon fixtures solely, but nevertheless it has to be carried on to a considerable extent. A minimum of a stated amount, without regard to the value of the property or the fixtures in it, must either be fixed so high that you cannot meter the small consumers or it will make the cost of the water prohibitive to them; so that at the first glance, it seems as though the committee in its report had hit somewhere near the right solution of the problem in some of its phases.

On the other hand, a minimum based upon frontage will not work equitably in all cases. Take it in a large city, houses and

flats, occupying perhaps 20 to 25 feet frontage, will not begin to pay the minimum rate of a small 4 to 6-room house in the outskirts, which might occupy and therefore pay on a 50-foot lot, while from their value and use of water such flats should pay a higher rate. Whether or not a minimum could be established that would do away with house-to-house inspection, based perhaps upon frontage plus height, or upon some method of valuation, I do not know. I think it is a question that could well be referred back to the committee in the light of the various experiences that have been given here.

Now, as to the question of rates, wholesale and retail, it seems to me that this is a logical way to sell water, and for this reason: The first cost of delivering water is the greatest, and the use of a maximum of 100 gallons a day, by one party, costs as much within certain limits to supply as to supply the same quantity to a person using 1 000 or 2 000 gallons a day. Of course when you get to a certain point where you have to enlarge your mains, that brings it under another classification. But in making out new schedules of rates it has always appeared to me that the fairest way to make meter rates is to charge for the first quantity of water, whatever it is, say 10 000 or 50 000 gallons a month, a stated price regardless of the ultimate quantity used. For the next quantity of water charge a lower price, and perhaps for a third and fourth larger quantity, getting up into the amounts that large mills would use, much lower prices. There is no question, then, of paying more for a lesser quantity than you do for a greater quantity. Every one pays an equal amount for the first quantity used, and it recognizes the principle that the supply of that first quantity costs just as much for one as it does for another. Then there is a point where within certain limits the only additional cost is the expense of pumping and perhaps purifying additional water, until the time that you have to lay larger mains; and you can afford to sell that excess at a much less price and still make a good profit on it. For that reason, and for the sake not only of encouraging manufacturers to use your water but to keep them from putting in supplies of their own, I think a sliding schedule on that basis is eminently proper.

MR. KENNETH ALLEN* (*by letter*). The committee's plan of a rate for water based both upon frontage and consumption appears reasonable and practicable. To devise a scheme that will be equitable in all cases seems to be as difficult as to find a practicable method of assessing for sewers and paving that will meet with universal approval; and we can only adopt that method which, while approximately fair to all, is at the same time not too cumbrous to put into practice.

One difficulty that would be avoided by the proposed plan is the fixing of a proper minimum rate. In the writer's opinion the minimum rate should, where used, represent the items — such as actual cost to the water department for installation and maintenance of service — for which the frontage rate is provided. Now, this is frequently a small sum in comparison with the value of water used, and if the minimum rate charged is much in excess of this amount the true value of the meter system is to that extent lost. In other words, the *ordinary* charge for water should be in excess of the minimum rate instead of the reverse, and the meter rate so adjusted as to provide the required revenue.

[On motion of Mr. Charles W. Sherman it was voted that the report of the committee be accepted and the committee continued.]

* Engineer and Superintendent of Water Works, Atlantic City, N. J.

PROCEEDINGS.

June Meeting.

Attleboro, Mass., June 28, 1905.

The June meeting of the Association was held at Attleboro, Mass., on Wednesday, the 28thinst., with an attendance of one hundred and fifty-three members and guests, as follows:

Members.

S. A. Agnew, C. H. Baldwin, L. M. Bancroft, J. E. Beals, F. D. Berry, J. F. Bigelow, J. M. Birmingham, George Bowers, C. L. Bowker, G. A. P. Bucknam, J. Burnie, L. Z. Carpenter, S. K. Clapp, L. P. Collins, M. F. Collins, M. J. Doyle, J. W. Ellis, W. E. Foss, F. L. Fuller, W. B. Fuller, H. F. Gibbs, J. C. Gilbert, A. S. Glover, J. A. Gould, J. O. Hall, W. D. Hubbard, J. W. Kay, W. Kent, G. A. King, W. F. Learned, J. W. Locke, A. A. Knudson, T. H. McKenzie, H. McLean, H. V. Macksey, D. A. Makepeace, W. E. Maybury, J. Mayo, F. E. Merrill, C. A. Mixer, F. L. Northrop, J. W. Smith, G. H. Snell, G. A. Stacy, J. T. Stevens, W. F. Sullivan, L. A. Taylor, R. J. Thomas, W. H. Thomas, J. L. Tighe, D. N. Tower, C. K. Walker, J. C. Whitney, W. P. Whittemore, L. J. Wilber, I. S. Wood, F. I. Winslow, G. E. Winslow, H. D. Woods. — 59.

Associates.

Ashton Valve Co., by C. W. Houghton; Harold L. Bond & Co., by Harold L. Bond; Henry A. Depser; Builders Iron Foundry, by F. N. Connet and A. B. Coulters; Coffin Valve Co., by H. L. Weston; Fred C. Gifford; Hersey Mfg. Co., by Albert S. Glover and Walter A. Hersey; Jenkins Bros., by R. H. Stiles; Lead Lined Iron Pipe Co., by T. E. Dwyer; H. Mueller Mfg. Co., by W. L. Dickel and O. B. Mueller; National Meter Co., by C. H. Baldwin and J. G. Lufkin; Rensselaer Mfg. Co., by F. S. Bates and C. L. Brown; Platt Iron Works Co., by F. H. Hayes; A. P. Smith Mfg. Co., by F. N. Whitcomb; Sweet & Doyle Valve Co., by H. L. DeWolfe; Thomson Meter Co., by S. D. Higley; Union Water Meter Co., by F. L. Northrop and W. F. Hogan; R. D. Wood & Co., by Wm. F. Woodburn. — 24.

Guests.

A. N. French, Supt., Hyde Park Water Co., Hyde Park, Mass.; John Kelley, Comr., and Mrs. W. E. Maybury, Braintree, Mass.; Mr. and Mrs. Walter Phillips, Weymouth, Mass.; Mr. G. W. Strandberg, Chas. McConnell James A. McKenna, Providence, R. I.; Elisha T. Jenks, H. W. Sears, A.

G. Hayes, Mr. Amos H. Eaton, Walter A. Beals, Middleboro Mass.; George A. Carpenter, Pawtucket, R. I.; Arthur C. King, Taunton, Mass.; A. L. Mixer, Rumford Falls, Me.; D. Kingman, H. H. Chase, Brockton, Mass.; N. B. Tower, Cohasset, Mass.; Andrew R. McCallum, Whitman, Mass.; I. C. Sears, E. A. Baxter, Hyannis, Mass.; Mrs. George E. Winslow, Waltham, Mass.; Mrs. Frederic I. Winslow, George W. Blodgett, Mr. and Mrs. E. S. Dorr, Katharine T. McCarthy, E. F. Clasby, Boston, Mass.; C. A. Peirce, Syracuse, N. Y.; W. H. Van Winkle, New York City; Mrs. Wm. F. Woodburn, Philadelphia, Pa.; Mrs. Willard Kent, Narragansett Pier, R. I.; Mrs. H. D. Woods, West Newton, Mass.; Mrs. George Bowers, Miss Helen E. Bowers, Lowell, Mass.; Mr. F. A. Leavitt, Malden, Mass.; B. Dwyer, Hartford, Conn.; Mrs. L. J. Wilbur, Brockton, Mass.; Mrs. H. A. Desper, Worcester, Mass.; L. P. Stone, Natick, Mass.; Mr. L. M. Hudson, Thomas Burke, Marlboro, Mass.; W. H. Day, Milford, Mass.; George H. Palmer, Wm. H. Goff, E. S. Horton, Peter Nemay, H. D. Baker, Caleb Slade, Willard A. Eugley, Alberta Remington, C. S. Holden, H. S. Robinson, E. O. Dexter, A. M. Briggs, J. F. Makinson, W. B. Ballou, Annie A. Wheeler, G. H. Sykes, Winthrop F. Barden, J. A. Welsh, C. C. Cain, Carrie L. Perry, S. M. Holman, H. E. Claf, E. J. Ivarmstrom, W. W. Stone, W. N. Goff, G. A. Sweeney, H. R. Packard, Edgar Tregoning, Attleboro, Mass., and Samuel Harrison, of the H. R. Worthington Co. — 73.

[Names counted twice —3.]

Special cars were attached to the regular train from Boston arriving in Attleboro at ten o'clock, where the party was met by the water commissioners of the town, and entertained as their guests during the day.

Automobiles were in waiting at the railroad station, and in these the party was quickly conveyed to the summit of Ides Hill, where an opportunity was afforded to inspect the reinforced concrete standpipe in process of construction, and incidentally much of the surrounding country, to the enjoyment of which the unusual clearness of the atmosphere materially contributed.

The work inspected includes a new well at the source of supply, constructed last year, and a reinforced concrete standpipe, now under construction.

The new well from which ground water is taken is situated on the banks of the Seven Mile River and is 40 feet in diameter and about 25 feet deep. The well is covered with a Guastavino tile roof.

To provide the necesary storage so that the pump run may be limited to the day hours a standpipe 50 feet in diameter and 100

feet high, of about 1 500 000 gallons capacity, is being constructed. It is situated on Ides Hill at an elevation of 252 feet above mean tide.

The walls are to be of concrete, mixed one part cement, two parts sand, and four parts crushed stone, particular care being taken in the grading of the aggregate, so as to reduce the voids to a minimum. The walls are to be 18 inches thick at the bottom and 8 inches at the top. Movable wooden forms in sections are used in placing the concrete in walls.

The interior surface is to be plastered with a mortar composed of cement, sand, glue, and alum, one-half inch thick, troweled to a granolithic finish.

The horizontal reinforcement is by circular steel bars, ranging in size from 1⅛ to 1½ inches diameter, spaced as made necessary by the pressure at different elevations. The vertical bars are of twisted steel ⅝-inch diameter staggered so as to permit the wiring of horizontal bars to them.

The standpipe is to be roofed by a Guastavino tile dome and is to be capped by a heavy concrete cornice.

The pump wells and station were visited, and a ride through the country thoroughly enjoyed. On the return to the village lunch was served, followed by a visit to some of the noted jewelry manufactories.

Immediately following lunch a brief business meeting was held.

Twelve applications for membership, recommended by the Executive Committee, were presented, and by vote of the Association the following-named applicants were elected members:

Luis Matamoros, Municipal Engineer, San José, Costa Rica; Charles H. Campbell, Superintendent of Water Works, Charlotte, N. C.; William W. Locke, Sanitary Inspector, Metropolitan Water and Sewerage Board, South Framingham, Mass.; Theodore A. Leisen, Chief Engineer, Water Department, Wilmington, Del.; Wallace Greenalch, Superintendent Bureau of Water, Albany, N. Y.; James M. Caird, Chemist and Bacteriologist, Troy, N. Y.; Charles M. Bolton, Superintendent of Water Works, Olympia, Wash.; Ralph Howard Garrison, Superintendent of Water Works, Sewerage System and Electric Light Plant, Vineland, N. J.; Arthur N. French, Hyde Park, Mass.; Alexander Macphail, Professor of General Engineering, Queens University, Kingston, Ont.; Clyde Potts, Sanitary Engineer,

New York City; George H. Felix, General Manager of Water Department, Reading, Pa.

The thanks of the Association were tendered by rising vote to the water commissioners and citizens of Attleboro for the courtesies which had rendered the day so enjoyable.

Mr. Snell responded in behalf of the commissioners, and Mr. J. Waldo Smith of the New York Committee on Annual Convention gave an interesting address on the plans of the committee and the arrangements being made for the meeting.

The President announced that the Annual Convention would be held in New York on the 13th, 14th, 15th and 16th of September.

WILLARD KENT, *Secretary.*

TWENTY-FOURTH ANNUAL CONVENTION.

NEW YORK CITY, September 13, 14, 15, 1905.

The Twenty-Fourth Annual Convention of the New England Water Works Association was held at New York City, on Wednesday, Thursday, and Friday, September 13, 14, and 15, 1905. The headquarters of the Association during the convention were at the Murray Hill Hotel, and the meetings were held there.

The following members and guests were registered:

MEMBERS.

S. A. Agnew, K. Allen, M. N. Baker, C. H. Baldwin, L. M. Bancroft, F. A. Barbour, H. K. Barrows, G. B. Bassett, G. W. Batchelder, J. E. Beals, E. W. Bemis, F. D. Berry, C. R. Bettes, J. M. Betton, J. F. Bigelow, J. M. Birmingham, F. E. Bisbee, G. H. Bishop, G. Bowers, E. C. Brooks, W. W. Brush, J. Burnie, C. E. Chandler, S. K. Clapp, H. W. Clark, W. F. Codd, R. C. P. Coggeshall, M. F. Collins, W. R. Conard, V. R. Connor, J. H. Cook, G. K. Crandall, A. W. Cuddeback, L. B. Cummings, F. A. W. Davis, J. M. Davis, M. J. Doyle, J. Doyle, E. R. Dyer, H. D. Eaton, E. D. Eldredge, J. W. Ellis, E. A. Ellsworth, E. A. Fisher, A. D. Flinn, R. J. Flinn, J. H. Flynn, A. A. Fobes, M. Forbes, E. H. Foster, G. H. Felix, J. R. Freeman, E. V. French, F. L. Fuller, G. W. Fuller, W. B. Fuller, S. DeM. Gage, E. W. Gaylord, W. P. Gerhard, W. B. Gerrish, D. H. Gilderson, A. S. Glover, R. H. Garrison, W. J. Goldthwait, X. H. Goodnough, F. W. Gow, E. H. Gowing, J. W. Graham, J. W. Griffin, C. A. Hague, A. S. Hall, J. C. Hammond, Jr., L. P. Hapgood, G. W. Hawkes, W. E. Hawks, W. C. Hawley, T. G. Hazard, Jr., A. Hazen, D. A. Heffernan, C. Herschel, W. R. Hill, H. G. Holden, F. S. Hollis, G. S.

Hook, J. A. Huntington, J. H. Ince, G. I. Ingersoll, D. D. Jackson, H. R. Johnson, W. E. Johnson, W. S. Johnson, A. J. Jones, J. W. Kay, E. W. Kent, W. Kent, P. Kieran, F. C. Kimball, G. A. King, T. A. Leisen, A. A. Knudson, M. Knowles, E. S. Larned, E. E. Lochridge, M. O. Leighton, H. A. Lord, F. H. Luce, C. M. Lunt, J. W. Lynch, D. B. McCarthy, S. H. McKenzie, T. H. McKenzie, Thomas McKenzie, Hugh McLean, D. E. Makepeace, W. M. Marple, W. P. Mason, W. E. Maybury, F. E. Merrill, D. S. Merritt, P. S. Miller, F. F. Moore, J. W. Moran, J. F. J. Mulhall, F. L. Northrop, E. L. Nuebling, O. E. Parks, C. L. Parmelee, D. H. Parsons, W. Paulison, E. M. Peck, E. L. Peene, E. B. Phelps, F. H. Pitcher, F. V. Pitney, A. Potter, G. S. Rice, W. H. Richards, T. F. Richardson, W. W. Robertson, G. A. Sanborn, W. J. Sando, W. H. Sears, E. M. Shedd, C. W. Sherman, M. R. Sherrerd, M. A. Sinclair, J. W. Smith, G. H. Snell, G. A. Soper, H. T. Sparks, J. F. Sprenkel, G. A. Stacy, J. T. Stevens, W. F. Sullivan, G. A. Taber, R. J. Thomas, W. H. Thomas, J. L. Tighe, D. N. Tower, L. L. Tribus, A. S. Tuttle, W. Volkhardt, E. L. Wallace, C. S. Warde, J. S. Warde, R. S. Weston, W. J. Wetherbee, G. C. Whipple, J. C. Whitney, W. P. Whittemore, L. J. Wilber, F. I. Winslow, G. E. Winslow, E. T. Wiswall, Timothy Woodruff, G. W. Wright, W. S. Wyman, W. G. Zick. — 178.

Honorary Members.

J. J. R. Croes, F. W. Shepperd. — 2.

Associates.

Allis-Chalmers Co., by F. D. Herbert, Arthur Warren, G. H. Berg, J. E. Lord, W. J. Sando, Timothy Lynch, P. C. Gibson, and C. G. Wingate; Ashton Valve Co., by C. W. Houghton; Roy S. Barker; Builders Iron Foundry, by A. B. Coulters; Coffin Valve Co., by H. L. Weston; Henry A. Desper; M. J. Drummond by John Amstadter and Walter S. Drummond; The Fairbanks Co., by F. A. Leavitt, C. O. Churchill, J. F. O'Brien, S. P. Cates, and Chas. H. White; Garlock Packing Co., by G. R. Noble, L. Bulkley, and J. E. Case; Fred C. Gifford; Hays Mfg. Co., by T. J. Nagle and R. C. French; Hersey Mfg. Co., by Albert S. Glover, J. A. Tilden, F. A. Smith, W. A. Hersey, and W. C. Sherwood; International Steam Pump Co., by J. D. A. Silva, W. F. Flynn, Sam'l Harrison, H. F. Peake, and E. F. Walker; Jenkins Bros., by J. F. Stiles and C. F. Webber; Kennedy Valve Co., by M. J. Brosnan and J. F. Morgan; Lead Lined Iron Pipe Co., by T. E. Dwyer and W. Lockwood; Ludlow Valve Co., by H. F. Gould; H. Mueller Mfg. Co., by T. F. Leary, Warren Hason, A. C. Pilcher, O. B. Mueller; National Meter Co., by John C. Kelley, C. H. Baldwin, J. C. Kelley, Jr., Fred S. King, W. P. Oliver, J. G. Lufkin; Neptune Meter Co., by C. A. Vaughan, T. D. Faulks, H. H. Kinsey, J. L. Wertz, Mr. Gammon; New York Continental Jewell Filtration Co., by R. E. Milligan; Pittsburg Meter Co., by T. C. Clifford and V. E. Arnold; The Platt Iron Works Co., by F. H. Hayes; Rensselaer Mfg. Co., by F. S. Bates, C. L. Brown, and J. S. Warde, Jr.; Ross Valve Co., by William Ross and Adam

Ross; Central Foundry Co., by Mark Dean and E. A. Scott; A. P. Smith Mfg. Co., by A. P. Smith, D. F. O'Brien, F. N. Whitcomb, and J. W. Strackbeim; Thomson Meter Co., by E. J. Snow, S. D. Higley, H. G. Folger, and J. C. Wilshin; Union Water Meter Co., by F. L. Northrop, W. F. Hogan, L. P. Anderson, E. F. King; U. S. Cast Iron Pipe and Foundry Co., by R. W. Martindale, Nathaniel Miles, W. B. Franklin, and H. H. Putnam; R. D. Wood & Co., by Wm. F. Woodburn and A. T. Prentice. — 87.

GUESTS.

Mrs. George E. Winslow, Mrs. F. C. Gifford, Mr. and Mrs. E. Earle Gifford, Minnie A. Gifford, Maud Durgin, Waltham, Mass.; Mrs. F. L. Fuller, Wellesley Hills, Mass.; Mrs. George A. Sanborn, Julia N. Collins, A. A. Schaake, Lawrence, Mass.; Mrs. D. N. Tower, Cohasset, Mass.; Mrs. Wm. H. Thomas, Hingham, Mass.; Edwin Leavitt, Lillian E. Leavitt, Mrs. Edward W. Shedd, Somerville, Mass.; Mr. and Mrs. A. W. Danforth, Lucy A. Danforth, Susette C. Berry, Mrs. L. M. Bancroft, Reading, Mass.; M. C. Damon, Wm. E. Lothrop, Leominster, Mass.; Mrs. J. Wm. Kay, Milford, Mass.; Mrs. L. J. Wilber, Campello, Mass.; Mary S. Goldthwait, Eleanor R. Goldthwait, Marblehead, Mass.; Mrs. John Doyle, Mrs. H. A. Desper, Charles F. Merrill, Worcester, Mass.; Mr. and Mrs. W. E. Hatch, Mrs. R. J. Thomas, Mrs. George Bowers, Miss Helen Bowers, Mrs. E. H. Scribner, Mr. and Mrs. I. E. Wotton, Mr. and Mrs. Z. W. Sturtevant, Lowell, Mass.; Mrs. E. L. Wallace, Franklin Falls, N. H.; Mrs. E. A. Ellsworth, Alice S. Corner, Mrs. M. J. Doyle, Mary Buckley, Miss Nellie Curran, George O. Connell, Holyoke, Mass.; George A. Wooley, Joan M. Ham, Margaret G. Flinn, Mrs. G. R. Noble, Mrs. Frank G. Kimball, George F. Hiller, Mrs. H. F. Gould, W. O. Weaver, Charles S. Shaughnessey, T. W. Norcross, Boston, Mass.; Winifred L. McGowan, No. Attleboro, Mass.; Elizabeth V. McDermott, Roxbury, Mass.; Mrs. D. A. Heffernan, Milton, Mass.; Mrs. D. E. Makepeace, Attleboro, Mass.; Mrs. E. C. Brooks, Mr. and Mrs. J. P. Bacon, Cambridge, Mass.; Everett I. Bray, M. J. McLaughlin, Gloucester, Mass.; J. J. McNally, Mr. and Mrs. G. M. McKelvey, Mr. and Mrs. H. M. Garlick, Mr. and Mrs. H. W. Heedy, Youngstown, O.; Mrs. W. E. Maybury, Braintree, Mass.; Mrs. Murray Forbes, Morton W. Crownover, Ass't Supt., and Paul L. Yount, Ass't Supt., Greensburg, Pa.; Mrs. C. A. Vaughan, Mrs. T. D. Faulks, Mrs. J. F. O'Brien, Wm. S. Crandall, Editor "Municipal News," Mr. and Mrs. W. H. Van Winkle, Mr. and Mrs. C. Van Houtten, Mrs. Allen Hazen, W. H. Fitch, Mrs. Alfred D. Flinn, Mr. and Mrs. Henry B. Machen, Dr. Henry T. Coggeshall, Mr. and Mrs. Thos. J. Gannon, Mrs. J. C. Hanlon, Edward L. Walker, John P. Reynolds, Jr., Mrs. George A. Taber, W. F. Stodder, Mrs. G. C. Whipple, Mrs. George W. Fuller, W. H. Van Winkle, Jr., Pierre Pullis, F. M. Griswold, G. E. Bruen, Mrs. Alexander Potter, John S. Hodgson, Editor "Municipal Journal," S. T. Henry, Asso. Editor "Engineering Record," Ant. Breneman, Myron S. Falk, Mary R. Clapp, Edward Nuebling, Jacob Thoma, Glen Marston, "Engineering News," C. W. DuB. Gould, W. B. Goentner, Miss Ella Ringelman, Mrs. H. B. Brougham.

Mrs. F. W. Shepperd, George H. Benton, T. S. McNally, R. S. Prindle, J. B. Newhall, Dr. and Mrs. J. O. Taylor, Miss A. G. Ambrose, Mrs. T. Freedman, Edward H. Babcock, Miss M. Mansfield, Mrs. K. T. Todd, Mrs. Frank Gascoigne, E. J. Buttenberm, "Municipal Journal," Mrs. F. S. Bulkley, A. E. Van Gieson, Raymond L. O'Brien, R. E. S. Geare, Frank Martin, Miss Elizabeth Pratt, Irving C. Bull, G. Everett Hill, Andrew Mayer, Jr., and Mrs. Fred F. Moore, New York City; Mrs. Washington Paulison, C. A. Terhune, Walter C. Hopper, Passaic, N. J.; Miss Eliza Codd, Nantucket, Mass.; Mrs. C. O. Churchill, Charles Davis, Mrs. Wm. F. Woodburn, Miss V. M. Rondeau, Springfield, Mass.; Mrs. W. E. Hawks, Bennington, Vt.; Mrs. J. M. Davis, Rutland, Vt., Dr. John B. Wheeler, Dr. and Mrs. F. E. Clark, George Q. Stone, J. E. Meagher, Burlington, Vt.; Mrs. Fred S. Bates, W. P. Mason, Jr., Troy, N. Y.; Mrs. E. W. Small, Portland, Me.; Mrs. George K. Crandall, Mrs. W. H. Richards, New London, Conn., Mrs. Willard Kent, Narragansett Pier, R. I.; Mrs. Edward L. Peene, R. W. Bogart, Jr., C. DeA. Bogart, Miss Susan M. Gould, Jos. F. LeCount, Yonkers, N. Y.; Mrs. J. H. Cook, Paterson, N. J.; Dr. John T. Collins, Whitman, Mass.; Mr. and Mrs. Thos. S. Peirce, Mrs. J. W. Vaughan, East Greenwich, R. I.; John M. Bancroft, Bloomfield, N. J.; Miss May I. Agnew, W. D. Agnew, Mrs. M. McConkey, Mrs. R. A. Nimmo, A. Kitteredge, Jersey City, N. J.; Mrs. D. H. Gilderson, Haverhill, Mass.; Mrs. W. J. Sando, Milwaukee, Wis.; Mrs. G. A. Trowbridge, West Newton, Mass.; Wm. O. Devoll, Wm. H. Pitman, Louis H. Richardson, New Bedford, Mass.; George W. Stevens, South Braintree, Mass.; R. Henry Jones, Supt., Norfolk, Va.; Mrs. George H. Felix, Mr. and Mrs. S. H. Close, Mr. and Mrs. M. Haabster, Mr. and Mrs. F. P. Heller, Edw. Elbert, Reading, Pa.; Mrs. J. F. Bigelow, Mr. and Mrs. Chas. H. Andrews, Mrs. George A. Stacy, Mr. and Mrs. F. A. McGill, Mr. Con. Flynn, Miss Flynn, E. S. Murphy, Frank Murphy, Marlboro, Mass.; Mrs. H. A. Lord, Ogdensburg, N. Y.; C. L. Beach, Mrs. Roy S. Barker, Miss Grace Anderson, Providence, R. I.; H. A. Holmes, Mrs. D. B. McCarthy, Miss Nellie Esmond, Waterford, N. Y.; Alex Orr, C. E., Supt., Gloversville, N. Y.; Olin H. Landreth, Prof. Union College, George Holtzmann, Schenectady, N. Y.; J. D. Landis, Mechanicsburg, Pa.; A. A. Reimer, Mrs. Mark Dean, F. A. Reimer, W. H. V. Reimer, Hon. Wm. Cardwell, F. Lardley, J. M. Brown, A. W. Baigrie, F. J. Greer, Mr. and Mrs. Daniel C. Osmun, E. S. Perry, J. N. Travis, Orange, N. J.; C. J. Barrett, South Orange, N. J.; F. A. O'Conner, West Orange, N. J.; Mr. and Mrs. J. M. Kinder, Meriden, Conn.; Perry T. W. Hale, Jas. Lawton, P. C. Denehy, Middletown, Conn.; Bartholomew Dwyer, James Orr, Southington, Conn., Miss Florence Serrell, North Plainfield, N. J.; Benj. I. Drake, Plainfield, N. J.; Mrs. W. C. Hawley, Harold A. Allen, Atlantic City, N. J.; Mr. and Mrs. C. D. Pollock, Mr. and Mrs. Sam'l F. Thomson, Miss Elizabeth Thomson, Mrs. Wm. R. Hill, Miss Alice Hill, Frank E. Connolly, Mrs. H. M. Mills, Mrs. C. C. Mulford, Alice C. Flinn, Thomas F. Flinn, Mrs. E. W. Keese, Miss S. A. Cross, Wm. R. Fleming, John F. Mead, Brooklyn, N. Y.; Mrs. W. B. Gerrish, Oberlin, Ohio; Mr. and Mrs. L. W. Anderson, Grand Rapids, Mich.; A. M. Campbell, Mrs. J. S. Warde, West

New Brighton, N. Y.; Mrs. J. D. Landes, Mechanicsburg, Pa.; Mrs. E. D. Eldredge, Onset, Mass.; Beekman C. Little, Rochester, N. Y.; George T. Cullen, John W. Murphy, John J. Creedon, Malden, Mass.; Mr. and Mrs. Richard Veale, Kearney, N. J.; Mrs. W. B. Fuller, Pittsburg, Pa.; Frank M. Collins, Walden, N. Y.; Edward B. Hiding, Chicago, Ill.; Charles P. Brightman, J. W. Milne, Mrs. Patrick Kieran, Fall River, Mass.; Miss Eva Brown, Miss Mattie Calhoun, Miss Emma Savage, Indian Orchard, Mass.; Mrs. F. H. Luce, Woodhaven, N. Y.; Chas. N. Oakes, Frank S. Dewey, Jr., Henry W. Sanderson, J. H. Packard, S. W. Hildreth, Westfield, Mass.; M. Otagawa, Tokio, Japan; J. Ralph Duyne, John E. Hill, Newark, N. J.; E. Frailey, W. H. Frailey, Lancaster, Pa.; Mrs. Charles R. Bettes, Far Rockaway, N. Y.; Charles R. Tucker, Staten Island, N. Y.; H. Dallas McCabe, Monessen, Pa.; Joseph E. Carroll, Lowell, Mass.; J. A. Nelson, Pittsburg, Pa.; Mrs. John F. J. Mulhall, Boston, Mass.; Frank Brigham, Elizabeth, N. J.; F. O. Sinclair, Burlington, Vt.; J. C. Richards, P. A. Maignen, Philadelphia, Pa.; Alfred M. Quick, Baltimore, Md.; Mrs. C. H. White, Jamaica, N. Y.; W. R. Scofield, Matteawan, N. Y.; Miss Capen, Miss Ethel Capen, St. Louis, Mo.; Edwin L. Newcomb, Vineland, N. J.; R. W. Pratt, George A. Johnson, Columbus, Ohio; Karl F. Kellerman, Washington, D. C.; Herbert B. Baldwin, Newark, N. J.; C. Arthur Brown, Lorain, Ohio; F. W. Green, Little Falls, N. Y.; John F. Gallagher, Kingston, N. Y.; Moses Joy, Milford, Conn.; W. D. Horne, Yonkers, N. Y. — 314.

Summary of attendance: Members, 178; Honorary Members, 2; Representatives of Associates, 87; Guests, 314; counted twice, 4; total, 577.

Wednesday, September 13.

The convention was called to order at ten o'clock by President George Bowers, and Mr. J. Waldo Smith, Chairman of the Local Committee, was presented. Mr. Smith spoke as follows:

Mr. President and Members of the New England Water Works Association, — It is particularly gratifying to the members of the various committees who have had the arrangements for this convention in charge to see such a large attendance at the opening session. We trust that nothing will interfere with the pleasures or the more serious duties of this gathering; that when you return to your homes it will be with the firm conviction that this has been the best convention ever held by the Association, and that you will have a desire to come here again. It seems particularly fitting that in breaking your custom once more and holding a convention outside of New England, the most influential water works association in the country should come to its largest and most influential city.

A very distinguished gentleman has kindly consented to come here this morning and say a few words on behalf of the city of New York, and I have now the honor to introduce to you, the corporation counsel of the greatest city in the world, the Hon. John J. Delany. [Applause.]

ADDRESS OF WELCOME BY THE HON. JOHN J. DELANY, CORPORATION COUNSEL OF THE CITY OF NEW YORK.

Mr. Chairman, Ladies and Gentlemen, — I regret very much that the mayor, who has just returned from his vacation to take hold of a large amount of deferred work, is unable to be here, because I believe he is the greatest water-works man in the world. He has been the prime agent in bringing about the extension of our water system.

We are now preparing plans for what will be the greatest water works ever known in the history of civilization. Whether in the old civilizations that have passed away, or in the new ones which have come up in these later years, I do not believe there have been any water works that will compare, when they are extended according to their general plan and scope, to the water works over which Mr. J. Waldo Smith will have the honor to preside, and whose destinies will be left in his keeping. [Applause.]

Gentlemen, you belong to a profession which does not appear in anything like its fullness in the beginning of civilizations. When cities are being formed you are not consulted, but when they grow in wealth and in prosperity, when human endeavor has enlarged the habitations of men around a given spot, when the complexity of human life in closely compacted centers makes it necessary to turn attention to those things which are required for the success of industrial efforts and for the preservation of human health, then the people turn to you with suppliant hands and ask you, like Moses, to be the deliverer of a great people. So you see you are rather distinguished, although perhaps you had not discovered it until this moment. [Applause and laughter.]

And you may also realize that your function in life is one most important. You are not present when a nation or a city is

cradled, nor are you present when a nation or a city goes down to decay, because it is only when it ceases to consult the engineer that a city topples to its ruin. When it would spread out in magnificence and in architectural and mechanical grandeur, then it has to be guided by the mature mind of the engineer.

I am impressed with the fact that you are like the men who brought God's beautiful water in olden times from the top of the mountains, down by devious routes into the valley to the thirsty people below. Now you do even more than that. You see that on its way down it shall not be contaminated, or, at least, if you do not do that, you are resorting to all means and employing all the ingenuity at your command to purify it from all contamination and to furnish an abundance of pure and wholesome water to strengthen the people and to help them along in their work of improvement and progress.

Gentlemen, there is not a place in the world more appropriate for the discussion of the bacteriological and the medical questions, as well as the mechanical problems involved in your great profession, than this great city, teeming with its millions of people, growing with a rapidity that is something marvelous, every year adding the numbers of a large city to its population. You come here to consult one with the other, to bring about the solution of questions which concern very gravely the public health of large communities. Modern bacteriology has pointed out to us that you water-works people are in the main those upon whom we must rely to guard us against that great and terrible affliction which comes so often upon the human race in large centers of population, and which under one name or another in antiquity and in modern times has decimated whole communities. I refer to that great scourge, typhoid fever. You will prescribe when you lay out our water works, and when you provide for their maintenance, such measures as will, if it is possible, prevent contamination by the germs of typhoid fever and kindred diseases. If you cannot prevent the contamination, you will study the problem and endeavor to solve the difficulty by destroying the germs after they get into the water supply. So you see, in your great profession, you are linked with the physician, and with the modern bacteriologist.

And all the time that you are doing your work you are working for two ends: first, the preservation of the health of the people, and second, the promotion of their industrial undertakings.

I welcome you here in behalf of the mayor of our city, who sends his regrets at his enforced absence. We offer you all that there is here for a stranger to see in this, the greatest city in the world, as Mr. Smith has very properly called it. This city is great, not only on account of her position, not only on account of the activity and enterprise of her own citizens, however great that may be, but on account of the coöperation with us of all the people throughout this magnificent land, who rest under the protecting ægis of the Stars and Stripes, our common heritage. And when you are endeavoring to solve these great problems for the preservation of the public health and for the promotion of the prosperity of the people, you are really in the position not merely of lowly workmen in the cause of humanity, but of co-laborers in the important work of the advancement of the human race.

I welcome you again, in my own behalf and on behalf of the mayor, to our great city. Its doors are flung wide open to you, and you can do as you please, because New York is not critical if a man does not put his foot through the penal code. [Laughter.] You may have different views than we have about some things. You may have different ideas than we have here, but we hope that after you have seen us for yourselves you can go back and say to the communities in which you live that you have never seen a large city in the world which is as good and as God-fearing as this great American city of New York. And you can say it justly, in spite of our own hypercriticism, for the lash is laid on our back by no one as hard as we lay it on ourselves, and our great prosperity and the fact that so many problems in modern city life have been solved here is largely due to the impetus which we have given to ourselves by the very criticism which we have so freely bestowed upon ourselves. We are not so bad as we would lead you to believe we are, and we want you to go around among us and find out that we are really the best people in the world. We hope you will make the effort to do so, anyway. [Applause.]

I thank you very much for this opportunity to meet you, I thank you for the attention with which you have heard me, and

as I have to go to another meeting now I will bid you good-morning, wishing you all success. [Applause.]

NEW MEMBERS ELECTED.

The Secretary read the following names of applicants for membership, all of whom had been duly recommended by the Executive Committee:

For Member. — Burt B. Hodgman, Civil Engineer, New York City; Richard W. Bogart, Jr., Hydraulic Engineer, National Board of Fire Underwriters, New York City; C. Arthur Brown, Sanitary Engineer, Lorain, Ohio; W. W. Burnham, Engineering Department, Hugh MacRea Co., Wilmington, N. C.; Frederick W. Carpenter, Assistant Engineer, New York Rapid Transit Com., New York City; Edward A. Clark, Kingston, N. Y.; David N. Cook, Superintendent Water Works, Salem, Mass.; L. W. Dalrymple, City Engineer, Bayonne, N. J.; P. C. Denehy, Assistant Superintendent Middletown Water Works, Middletown, Conn.; Benj. I. Drake, of Drake & Thorp, Plainfield, N. J.; Bartholomew Dwyer, Assistant Superintendent, Hartford Water Works, Hartford, Conn.; J. W. R. Fitzpatrick, Civil and Mechanical Engineer, Cohoes, N. Y.; W. B. Goentner, Assistant Engineer, National Board of Fire Underwriters, New York City; J. W. DuB. Gould, Hydraulic Engineer with National Board of Fire Underwriters, Yonkers, N. Y.; Thomas Joseph Gannon, Mechanical Engineer, with Department of Water Supply, Gas, and Electricity of New York City, Brooklyn, N. Y.; Edward D. Hardy, Superintendent Filtration Plant, Washington, D. C.; Perry T. W. Hale, Superintendent and Engineer Middletown Water Works, Middletown, Conn.; George A. Johnson, Engineer in charge Sewage Testing Station, Columbus, Ohio; R. Henry Jones, Superintendent Water Works, Norfolk, Va.; Charles T. Kavanagh, Water Purveyor, City of Bayonne, N. J.; George G. Kennedy, Superintendent Water Works, Harrisburg, Pa.; Beekman C. Little, Superintendent Water Works, Rochester, N. Y.; James A. Locke, with New York Rapid Transit Commission, White Plains, N. Y.; Henry B. Machen, Assistant Engineer, Rapid Transit Commission, New York City; H. Dallas McCabe, Superintendent Monessen Water Co., Monessen, Pa.; E. H. Nordendahl, Member Committee of 20, National Board of Fire Underwriters, Brooklyn, N. Y.; Theodore W. Norcross, Hydrographic Aid in New England of United States Geological Survey, Medford, Mass.; Edward A. Northey, Chief Inspector with New England Bureau of United Inspection, Salem, Mass.; Geo. H. Palmer, Chief Engineer, Attleboro Pump-

ing Station, Attleboro, Mass.; Thomas T. Peirce, Superintendent and Treasurer, East Greenwich Water Supply Co., East Greenwich, R. I.; Clarence DuBois Pollock, Assistant Engineer of Highways, Brooklyn, N. Y.; Alfred M. Quick, Chief Engineer, Baltimore Water Department, Baltimore, Md.; Arthur A. Reimer, Superintendent East Orange Water Department, East Orange, N. J.; John P. Reynolds, Jr., Mechanical Engineer with Department of Water Supply, New York City; Wm. M. Stone, Chairman of Water Board, Attleboro, Mass.; Jacob Thoma, with Department Water Supply, High Pressure Fire System, New York City; Ernest P. Whitten, Civil Engineer, Stewart Station, Pa.; Charles M. Woodward, Water Commissioner, West Springfield, Mass.

For Associate. — W. H. Fitch, Eastern Manager, Walter Macleod & Co., New York City; Walter H. Van Winkle, General Manager, Water Works Equipment Company, New York City.

By direction of the meeting, on motion of Mr. Fuller, the Secretary cast one ballot in favor of the applicants above named, and they were declared elected.

STANDARD PIPE SPECIFICATIONS.

The President announced the receipt of a communication in regard to Standard Specifications for Cast-Iron Pipe, which he called upon Mr. Sherman to read. The communication was as follows:

NEW YORK CITY, August 30, 1905.

THE NEW ENGLAND WATER WORKS ASSOCIATION,
715 TREMONT TEMPLE, BOSTON:

Gentlemen, — J. J. R. Croes, C. E., Chairman Committee on Standards of the American Water-Works Association, has appointed a conference committee consisting of J. Waldo Smith, C. E., Theo. A. Leisen, C. E., with myself as chairman, and I write to request that you appoint a committee of three to meet with us regarding standard pipe specifications. There will also be represented American Testing Association and the Western Society of Engineers, to whom I am writing to-day with reference to the subject.

Kindly let me hear from you at your early convenience and oblige,

Yours very truly,

(Signed) CHAS. A. HAGUE,
Chairman Conference Committee.

MR. CHARLES W. SHERMAN. A number of years ago this Association appointed a committee on standard specifications for cast-iron pipe, and after about a year's work and extensive discussion of preliminary specifications submitted by the committee, the committee finally reported a set of specifications which was adopted by the Association, and which has been used quite extensively since that time, particularly in New England, with very good success, I think, by those members who have used it, — certainly by those in the large communities who have been buying pipe in sufficiently large quantities. There has been some feeling that we have done enough in this direction and that we should now lie on our oars.

I think, however, it is desirable that we should be represented in this proposed conference, and that if, as many of us think, the specifications which we have already adopted are as good as can be prepared at this time, our committee should work to secure their acceptance by the other societies. If, on the other hand, these other societies can present satisfactory reasons why the specifications which have now been used for some three years should be modified, there is no doubt, I believe, that the Association would be glad to consider the suggested modification, and presumably would accept it on the report of an able committee.

I would therefore make a motion, Mr. President, that Mr. Freeman C. Coffin, Mr. Dexter Brackett, and Mr. F. F. Forbes, who composed the original committee which draughted our specifications now in force, be requested to act as a committee of conference in meeting these other committees and discussing the question of standard specifications for cast-iron pipe. I would say further that I have been able to talk this matter over to some extent with Messrs. Coffin and Brackett, and although they have, perhaps, done as much work in this direction as it is really proper for the Association to call on them to do, I think that they would be willing to give what time may be necessary to a conference of this kind, and would see that the Association's standard is presented to these other committees, and at least consider the subject further and report back to the Association.

The motion was adopted, and the President appointed the committee as suggested by Mr. Sherman.

COURTESIES EXTENDED.

The Secretary read the following letter from the Ryan-Parker Construction Company:

"In connection with the annual convention of the Association to be held at New York City, in case any of the members are interested in the construction of retaining walls and brickwork, we would be pleased to extend to them an invitation to visit the contract we now have under way for the extension of Riverside Drive from One Hundred Thirty-Fifth Street north. The contract for this work, the cost of which is approximately $1 500 000, consists mainly of heavy concrete foundations and retaining walls with facings of finely dressed granite."

On motion of Mr. Sherman it was voted that the Secretary be instructed to write to the Ryan-Parker Construction Company, and to the other companies from whom communications have been received extending courtesies to the members of the Association during the convention, expressing the thanks of the Association.

The report of the Committee on Meter Rates was then taken up. In the absence of Mr. Coffin, chairman of the committee, Mr. Frank E. Merrill presented the report. In view of the fact that advance copies had been circulated it was deemed unnecessary to read the report in full, and gentlemen were invited to proceed to discuss it. The discussion was opened by Mr. Clemens Herschel, who contributed a written paper which was read by Mr. Sherman. The other gentlemen who took part in the discussion were Messrs. Allen Hazen, Edward W. Bemis, Charles W. Sherman, Walter H. Richards, T. H. McKenzie, Hugh McLean, Frank L. Fuller, F. A. W. Davis, W. C. Hawley, Robert J. Thomas, and Frank C. Kimball. On motion of Mr. Sherman it was voted to accept the report and to continue the committee.

The next matter on the program was the report of the Committee on Private Fire Services. In the absence of Mr. F. H. Crandall, chairman of the committee, Mr. Thomas, a member of the committee, suggested that the matter be laid over until the paper on Fire-Service Meters, by Mr. E. V. French, had been presented, inasmuch as he understood that Mr. French's paper would be on the lines which the committee had been endeavoring to work out.

On motion of Mr. Sherman it was voted that the President appoint a nominating committee to bring in a list of nominations for officers for the ensuing year. The President subsequently appointed Messrs. Frank E. Merrill of Somerville, Allen Hazen of New York, Michael F. Collins of Lawrence, Edward L. Peene of Yonkers, N. Y., and F. E. Bisbee of Auburn, Me.

At the afternoon session Mr. E. V. French, C. E., of Boston, presented a paper on "Fire-Service Meters." The discussion which followed, relating also to Mr. Wm. T. Sullivan's paper on "Tests of Large Meters," was participated in by Messrs. Edward W. Bemis, Frank C. Kimball, J. A. Tilden, William F. Sullivan, George A. Stacy, Lewis H. Nash, Robert J. Thomas, F. A. W. Davis, and Morris R. Sherrerd. At the conclusion of the discussion, on motion of Mr. W. C. Hawley, it was voted that the Committee on Private Fire Services consider and report a method or methods by which the value of fire protection can be estimated; and on motion of Mr. George A. Stacy the committee was enlarged by the addition of Mr. George W. Batchelder and Mr. Hugh McLean.

Adjourned.

In the evening the party visited the New York Hippodrome.

THURSDAY, SEPTEMBER 14.

At the opening of Thursday-morning session the Secretary announced that applications for membership had been received from the following-named persons, approved by the Executive Committee:

Richard Veale, Superintendent Water Department, Kearney, N. J.; J. Ralph Van Duyne, Assistant Superintendent Newark Water Department, Newark, N. J.; George E. McLaughlin, M.D., Bacteriologist, Jersey City, N. J.; Myron S. Falk, Consulting Engineer, New York City; Edward Nuebling, Draughtsman, Long Island City, N. Y.; L. M. Anderson, City Engineer, Grand Rapids, Mich.; G. Everett Hill, Civil and Sanitary Engineer, Orange, N. J.; Edward L. Walker, with the Aqueduct Commission, New York City; Samuel F. Thomson, employed on the additional water supply for New York City; Orville J. Whitney, Superintendent Medford Water Works, Medford, Mass.

On motion of Mr. King the Secretary was requested to cast

one ballot in favor of the applicants named, and he having done so they were declared elected members of the Association.

The first matter on the program was the report of the Committee on Uniformity of Hose and Hydrant Threads, presented by Mr. George A. Stacy, of Marlboro, chairman. The subject was discussed by F. M. Griswold and E. V. French. On motion of Mr. Frank C. Kimball it was voted that the report of the committee be accepted and the standard recommended be adopted as the standard of the New England Water Works Association.

On motion of Mr. Frank L. Fuller it was voted that the President appoint a committee of three to consider the subject of uniformity in the direction of opening hydrants and gate-valves, and of size and shape of hydrant and gate nuts. The President subsequently appointed as a committee Frank L. Fuller, Frank C. Kimball, and Edward V. French.

The convention was then addressed by Prof. W. P. Mason, of Troy, who read a paper on the "Relation of Intensity of Typhoid Fever to Character of Water Carriage." Messrs. George A. Soper, F. A. W. Davis, M. N. Baker, George W. Wright, and George C. Whipple took part in the discussion.

The next paper was by Mr. John F. J. Mulhall, of Boston, and was on the subject, "Water Works Accounting." The subject was further discussed by Mr. W. C. Hawley, Mr. A. A. Reimer, and Mr. Edward W. Bemis.

Mr. W. B. Gerrish, of Oberlin, Ohio, then read a paper on "The Water Softening Plant at Oberlin, Ohio." Mr. Frederick S. Hollis, Mr. George C. Whipple, and Mr. Robert S. Weston spoke on the subject.

The President announced that Mr. G. S. Hook had prepared a leaflet on the "Electric Pumping Station of the Schenectady Water Works, Rotterdam, N. Y.," for distribution, and that he would like to say a few words on the subject.

Mr. G. S. Hook. I will not attempt to discuss the general subject of electric pumping, because it is a large matter and deserves more time than can now be given to it. I would simply say that from the point of view of the fire-protection engineer, who is coming to the front so rapidly in these days, and also from the point of view of the water-works man, it seems that the question of

electric pumping will, according to the local conditions encountered, be a question that will be up for solution in many cases where economies will be derived from its use.

The little leaflets which I wish to place in the hands of the Secretary for distribution to any of the members who desire to learn our data on the matter, were gotten out for the information of the New York State Fire Chiefs' Association, at the time they met in Schenectady last May, and it occurred to me that they might be of interest to members of this Association. Later on I expect that the question will become a very large one. The city of Schenectady places its total reliance on its electric company, and was probably the first city in the country to do so. Buffalo has followed suit, I understand, and has had electric pumps in operation about two months. Other places are considering the question, and I have been lately informed that the New York Auxiliary High-Pressure Fire Supply has let a contract for Brooklyn, and contracts are pending for an equipment of emergency pumps in the highlands of Manhattan. Of course this opens up a question which is of rather more interest to the fire protectionists than to water-works men, but these installations show the trend of practice. I have called attention to the matter hoping that it may lead to the presentation of some papers for discussion at future meetings of the Association.

Adjourned.

The afternoon and evening were devoted to a trip by boat around New York Harbor and a visit to Coney Island.

FRIDAY, SEPTEMBER 15, 1905.

Applications for membership were presented from the following:

F. O. Sinclair, engaged in general engineering, Burlington, Vt.; P. A. Maignen, designer of water-purifying plants, Philadelphia, Pa.; Weldon D. Griffin, Arlington, N. J., Assistant Superintendent, New York & New Jersey Water Co.; John E. Hill, Civil Engineer, Newark, N. J.; M. Otagawa, Superintendent and Chief Engineer Water Works, Tokio, Japan; W. R. Scofield, Superintendent Matteawan Water Department, Fishkill Landing, N. Y.

These applications having been duly approved by the Executive Committee, the Secretary was directed to cast one ballot in favor

of the candidates, and he having done so, they were declared elected members of the Association.

The announcement on the program for the morning session was "Symposium on the Relation of Copper Sulphate to Water Supply Matters." It was opened by Dr. George T. Moore, of Washington, with a statement of the general problem, with special reference to the use of copper sulphate as an algicide. Then Prof. W. P. Mason, of Troy, spoke on the use of copper sulphate to guard against typhoid fever epidemics coming from unfiltered surface water supplies. Other papers were read as follows: By Mr. D. D. Jackson, of Brooklyn, on the "Destruction by Copper Sulphate of Typhoid Fever Germs"; by Prof. Henry Kraemer, of Philadelphia (read by Dr. Newcomb), on "Germicidal Properties of Metallic Copper"; by Prof. Herbert E. Smith, of New Haven, on "Toxicological Aspects of the Copper Sulphate Treatment"; by Mr. J. W. Ellms, of Cincinnati (read by Mr. G. C. Whipple), on "The Behavior and Uses of Copper Sulphate in the Purification of Hard and Turbid Waters"; by Mr. George A. Johnson of Columbus, Ohio, on "The Application of Copper Sulphate to the Effluents of Coarse Grained Sewage Filters"; by Mr. H. W. Clark, of Boston, on "Copper Sulphate in Connection with Water Filtration."

There was then a general discussion of the copper question, by Mr. X. H. Goodnough, of Boston; Mr. Karl F. Kellerman, of Washington; Mr. E. B. Phelps, of the Massachusetts Institute of Technology; Mr. Robert S. Weston, of Boston; Dr. George A. Soper, of New York; Mr. Allen Hazen, of New York; Mr. G. A. Johnson, Mr. P. A. Maignen, Mr. G. C. Whipple, and Dr. E. L. Newcomb; and the gentleman who presented papers closed the discussion.

On motion of Mr. Davis the thanks of the Association were extended to those gentlemen, not members, who had presented papers.

At the opening of the evening session the following were elected active members:

Lewis W. Dayton, Oyster Bay, L. I., Superintendent, Green Island Water Supply Co. and General Manager Nassau County Water Co.; W. D. Horne, Yonkers, N. Y., engaged in chemical work; Fred R. Betts, Assistant Engineer in charge of Surveys and Construction, Department of Water Supply, New York City.

On motion of Mr. Sherman, the thanks of the Association were extended to the New York Central & Hudson River Railroad Company and to its chief engineer, Mr. Wm. J. Wilgus, through whose courtesy a special train was tendered for the visit to the Croton dam, the next day; also to the New York Rapid Transit Company mission for facilities afforded for inspecting the subway and power house, and to the Aqueduct Commission of New York. Mr. Sherman added, "If it were proper, I should like also to move a vote of thanks to the committee in New York which has so splendidly arranged for this our most successful as well as our largest convention. Since, however, they are all members of the Association I suppose that it is not proper for me to make that as a motion, but I want it to go on record that we all feel that we are just as much indebted to them as though we could pass them a vote of thanks." [Applause.]

Mr. H. K. Barrows, Civil Engineer, of Boston, delivered an address, illustrated by stereopticon, on "Some Features of Estimating Stream Flow in New England."

Mr. G. C. Whipple, Civil Engineer, of New York, delivered an address, also illustrated by the stereopticon, on "The Water Supplies of the New York Metropolitan District and Vicinity, with Special Reference to their Purification."

Adjourned.

SATURDAY, SEPTEMBER 16, 1905.

A visit was made to the new Croton dam, Plate I, Fig. 1, a special train having been provided by courtesy of the New York Central & Hudson River Railroad Company for the transportation from New York to Croton and return. Refreshments were served on the dam.

A feature noted by many was the reproduction of the badge of the Association around the fountain below the dam, as shown in the accompanying view. (Plate I, Fig. 2.)

EXHIBITS OF ASSOCIATES.

The following associates made exhibits:

Allis-Chalmers Co.,	Pumps.
Barker Well Co.,	Well-drilling apparatus.

FIG. 1. NEW CROTON DAM, SEPTEMBER 16, 1905.

FIG. 2. FOUNTAIN BELOW NEW CROTON DAM, SEPTEMBER 16, 1905.

Central Foundry Co.,	Universal pipe.
Coffin Valve Co.,	Valves and hydrants.
Fairbanks Co.,	Valves and hydrants.
Fire & Water Engineering Co.,	Publications.
Garlock Packing Co.,	Packings.
Hays Mfg. Co.,	Brass goods.
Hersey Mfg. Co.,	Meters.
Jenkins Brothers,	Pumps, valves, and packing.
Kennedy Valve Co.,	Valves and hydrants.
Lead Lined Iron Pipe Co.,	Lead lined iron pipe.
Macleod, Walter & Co.,	Lights, lead furnaces, and heaters.
H. Mueller Mfg. Co.,	Brass goods.
Municipal News,	Publications.
National Meter Co.,	Meters.
Neptune Meter Co.,	Meters.
Pittsburg Meter Co.,	Meters.
Rensselaer Mfg. Co.,	Valves and hydrants.
Ross Valve Co.,	Valves.
Smith, A. P., Mfg. Co.,	Tapping machines, brass goods, and specialties.
Thomson Meter Co.,	Meters.
Union Water Meter Co.,	Meters.
Water Works Equipment Co.,	Tapping machines and valves.
Worthington, H. R.,	Pumps and meters.
Wood, R. D., & Co.,	Pipe, hydrants, and valves.

FRED. N. WHITCOMB,
Chairman Exhibit Committee.

MEETINGS OF THE EXECUTIVE COMMITTEE.

ATTLEBORO, MASS., June 28, 1905.

Present: President George Bowers and George A. Stacy, James L. Tighe, Frank E. Merrill, Robert J. Thomas, Lewis M. Bancroft, and Willard Kent.

Six applications are received and recommended for membership viz.:

Charles M. Bolton, Olympia, Wash.; Ralph Howard Garrison, Vineland, N. J.; Arthur N. French, Hyde Park, Mass.; Alexander Macphail, Kingston, Ontario; Clyde Potts, New York City; George H. Felix, Reading, Pa.

The President presents form of lease of Headquarters at Tremont Temple, for three years, at four hundred dollars per annum, recommended by sub-committee, whereupon it is voted: that the same be approved and that the President and Secretary are authorized to execute the same on behalf of the Association.

Mr. J. Waldo Smith, of the New York Committee on Annual Convention, very interestingly outlined the plans of the committee in relation thereto, and after discussion the President announced that the date of the convention would be September 13, 14, 15, and 16.

Adjourned.

Attest: WILLARD KENT, *Secretary.*

NEW YORK, September 13–15, 1905.

The Executive Committee met from time to time during the convention and approved applications for membership, but transacted no other business.

WILLARD KENT, *Secretary.*

OBITUARY.

August Fels, member of the Lowell Water Board, died July 3, 1905, as the result of an accident, having been thrown from the carriage while driving.

Mr. Fels was born in Dombirn, Switzerland, February 7, 1844. He came to this country about 1862. In 1864, he became superintendent of a woolen mill at Steventown, N. Y., and about a year later, of a similar mill at Paterson, N. J., where he remained until 1877, when he became agent of the Merrimack Woolen Mills at Lowell.

In 1894 he was elected to the Lowell Water Board, and remained a member until his death. He is survived by a wife and five children.

Mr. Fels was elected a member of the New England Water Works Association on September 13, 1899.

Frank L. Fales, assistant engineer on the extension of the Cincinnati Water Works, died October 5, 1905, in Denver, Colo., where he had gone for his health.

Mr. Fales was born in Milford, Mass., in 1865. He was a graduate of Harvard University in the class of 1888, after which he studied engineering in Switzerland and at the Lawrence Scientific School. He was for several years in the office of the Massachusetts Metropolitan Water Board, but had been since about 1900 with the commissioners of water works, Cincinnati, Ohio.

He was a member of the Boston Society of Civil Engineers, and an associate member of the American Society of Civil Engineers. He was elected to membership in the New England Water Works Association on December 13, 1893.